REPORT

OF THE

Third Reviewing Committee

OF THE

COUNCIL OF SCIENTIFIC
AND INDUSTRIAL RESEARCH

FOREWORD

The work of the Third Reviewing Committee of the Council of Scientific & Industrial Research was carried out during the last months of the life of the Prime Minister of India, Pandit Jawaharlal Nehru, who was the President of its Governing Body, and the tragic news of his death came when our report was in an advanced stage of preparation.

This is not the place for a full appreciation of his great services to Indian scientific development but we wish to place on record our recognition of the wise, unique and devoted contribution which Shri Nehru made to the work of the Council.

We join with the Council in mourning the loss and in seeking inspiration for the future from his example and leadership.

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Part I

CHAPTER 1

INTRODUCTION

1.1 Terms of Reference and Membership

The Third Reviewing Committee was appointed in November 1963 by the Prime Minister in his capacity as President of the Council of Scientific & Industrial Research. The terms of reference of the Committee were "to review the work and progress of the Council of Scientific & Industrial Research and to recommend the lines on which the activities should be directed in the national perspective."

The Committee consisted of the following:

Chairman

SIR A. RAMASWAMI MUDALIAR
"India Steamship House"
21 Old Court House Street
Calcutta

Members

SHRI K. T. CHANDY
Director
Indian Institute of Management
Calcutta

DR. S. DHAWAN
Director
Indian Institute of Science
Bangalore

SIR CHARLES F. GOODEVE F.R.S.
Director
British Iron & Steel Research Association
London

SIR PATRICK LINSTEAD F.R.S.
Rector
Imperial College of Science & Technology
London

PROF. P. C. MAHALANOBIS F.R.S.
Member
Planning Commission
New Delhi

DR. S. R. SEN GUPTA
Director
Indian Institute of Technology
Kharagpur

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Dr. D. S. Kothari, Chairman, University Grants Commission was a member of the Committee and attended the first meeting held on November 4, 1963, but later discontinued his membership due to pressure of other work.

Shri Baldev Singh, Research Coordination, Industrial Liaison and Extension Officer of the CSIR was appointed Secretary of the Committee.

1.2. Mode of Working

The work of the Committee was carried out by visits to most of the research stations by one or more of its members and by discussions with their Directors and senior members of the scientific staff. Visits and discussions were also arranged with representatives of the Cooperative Research Associations of industry and with officers of some of the research institutions outside the purview of the Council.

The Committee also held discussions with the Chairman of the University Grants Commission, with a number of scientists from universities and organisations outside the CSIR, such as the Indian Council of Agricultural Research, Indian Council of Medical Research, Defence Research & Development Organisation, representatives from industries and government departments responsible for industrial development and with members of the Planning Commission. The Committee also had the benefit of detailed discussions with Dr. S. Husain Zaheer, Director General, Scientific & Industrial Research, and with officials of the Council (see Appendix I).

The Indian members of the Committee first met on November 4, 1963 at New Delhi. With the arrival in India of Sir Charles Goodeve and Sir Patrick Linstead, the second meeting was held at Hyderabad on January 28, 1964. The Committee was in continuous session from February 15 to February 21, 1964 at New Delhi to conclude its discussions and set out its recommendations.

A draft report was compiled by the Secretary and circulated to members in June 1964. Since it was not possible for Sir Charles Goodeve and Sir Patrick Linstead to come again to India, the Chairman decided that the Secretary should go over to London for discussing the draft with them. The Secretary reached London on July 13, 1964 and the draft was discussed with the British members. A revised draft of the report was sent to all members at the end of July. The Indian members of the Committee were in continuous session at New Delhi from September 4 to 8, 1964 for discussion and finalisation of the revised draft. The last meeting of the Committee was held on September 21, 1964 at Calcutta, for final approval and the signing of the report.

1.3. Previous Reviews

The Council's work was first reviewed in 1947 by a Committee under the Chairmanship of Sir Ardeshir Dalal. The Committee decided to confine itself to an examination of the utilisation aspects of the researches carried out under the auspices of the Council. At that time, the Council had been barely eight years in existence and its work mostly consisted of solving problems arising during the Second World War such as development of substitutes for materials in short supply due to military demand and stoppage of imports. With the termination of hostilities in 1945, the research activities of the Council shifted to the civil field.

The Council had at that time only two laboratories, now named the National Physical Laboratory and the National Chemical Laboratory, and these were not yet housed in independent buildings. It had a total budget of Rs 5.26 million (1947-48), and had already begun to earn revenue arising from its inventions.

While the Committee of 1947 did not recommend any hard and fast division of expenditure on fundamental and applied research, it emphasised that the greater part of the activities of the Council should be diverted to scientific research which could be applied directly towards the industrial development of the country. It pointed out that "owing to absence of facilities for pilot plant work, processes have been given out to industry in a half-baked condition, with the result that many industrialists find themselves unable to try them to a practical and profit yielding stage." It recommended that "provision for pilot plants should be expedited and that in the building programme, the technological blocks should have the first priority." The Committee counselled against taking up research schemes of a very vague and comprehensive character. It suggested that "before a scheme is sanctioned...........its exact scope and purpose is clearly defined and it fits in with the plan of development. No scheme should be sanctioned unless it involves real research which has not been carried out in other countries or, if such research has been carried out, it involves adaptation to Indian conditions and Indian raw materials."

The Committee emphasised the need for a closer liaison between industry and research and suggested that for proper utilisation, a Research Development Corporation on the lines of that in U.K. should be set up. It also suggested that the Council should be represented on all major trade associations and Chambers of Commerce.

1.3.2. The Second Reviewing Committee was appointed in 1954 under the Chairmanship of Sir Alfred Egerton. In its report the Committee welcomed the policy of establishment of modern laboratories covering a range of subjects of research in science and industry and drew attention to branches of science which could be helped to advance. Twelve laboratories had aready been established and the Committee suggested that the Directors should be given as much freedom from administrative work as possible to allow them more time to exercise scientific guidance. It emphasised the need of closer relationship between the CSIR laboratories and the universities and the use of the excellent facilities of the laboratories by post-graduate students and staff of universities where possible. Attention was also drawn to the need of attracting young engineers into research.

With the growth in the number of laboratories, the need for close coordination between them and also coordination with institutes and laboratories outside CSIR, was pointed out. The need of Central Research Intelligence to keep in close touch with the laboratories was stressed and closer coordination and cooperation with agricultural and medical research services was recommended. Arrangements were also suggested for the utilisation of the results of research by government departments and the industries and emphasis was placed on pilot plant work and help by the National Research Development Corporation.

The Committee welcomed the formation of Research Associations of Industry with partial government support where the size of the industry so warranted. Industry was also advised to make full use of facilities provided by the National Laboratories. The Committee made a comparison of the expenditure on research in India with that of other industrialised countries. Recommendations in regard to some individual laboratories were also made.

These recommendations of the Committee were referred to a Special Committee of the Governing Body of the CSIR under the Chairmanship of Sir J. C. Ghosh for examination who then made specific recommendations for measures to be taken for the implementation of the Report of the Second Reviewing Committee.

1.4. The Lay-Out of the Current Report

This Report of the Third Reviewing Committee is drawn up in four parts.

The first as an introduction describes the activities of the CSIR as they exist today. Then follows an outline of these problems of India in the solution of which research can be expected to play a major part. (Chapters 1 to 4). In Part II are outlined the main principles against which the activites of the CSIR should be judged. These are followed by recommendations that arise as a result of the application of these principles to individual parts of the research organisation. (Chapters 5 to 10). The remaining important issues and activities of the CSIR are dealt with in Part III (Chapters 11 to 15) and a summary and a list of the principal recommendations and appendices are in Part IV. (Chapter 16).

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1.5. Acknowledgements

The Committee wishes to express its thanks and appreciation of the valuable assistance it has received from individual associations, the research laboratories of the CSIR and other institutions and for the cooperation that they extended to the Committee in its work. Scientists outside the CSIR, industrialists in various centres and secretaries and departmental heads of the Central Government have cooperated by giving their views to the Committee. The Directors of all the Laboratories have spared no pains in sending publications and latest detailed accounts of the working of the laboratories and the Committee has largely drawn on this information for its comments and conclusions. Some of the Directors and their Staff have given their views personally to the Committee or its individual members, and have helped them in going through the laboratories and noting the work that is being done. To all of them the Committee is greatly indebted and would like to place on record their appreciation of the cooperation they have extended to the Committee in its work.

The Committee had the benefit of continuous consultation with the Director General of the CSIR and was so enabled to understand the detailed working of the Council and its laboratories and organisations at Headquarters. We are indebted to the Director General for his helpful cooperation. The Committee would like to record with great appreciation the services of its Secretary, Shri Baldev Singh, who has spared no pains in helping the Committee in its work and in preparing of this Report. The Committee would like to convey its special recognition of his services.

The Committee would also like to convey its thanks to the other members of the staff who helped the Committee in its work in various ways.

CHAPTER 2

HISTORY AND BRIEF DESCRIPTION OF CSIR

2.1. Organisation and Functions

The Council of Scientific & Industrial Research was set up in 1942 as an autonomous body registered under the Registration of Societies Act (Act XXI of 1860). The functions assigned to the Council are:

1. The promotion, guidance and coordination of scientific and industrial research in India including the institution and the financing of specific researches.
2. The establishment of development and assistance to special institutions or departments of existing institutions for scientific study of problems affecting industries and trade.
3. The establishment and award of research studentships and fellowships.
4. The utilisation of the results of the researches conducted under the auspices of the Council towards the development of industries in the country.
5. The establishment, maintenance and management of laboratories, workshops and organisations; to further scientific and industrial research and to utilise and exploit for purposes of experiment or otherwise any discovery or invention likely to be of use to Indian industries.
6. The collection and dissemination of information in regard not only to research but also to industrial matters generally.
7. Publication of secientific papers and a journal of industrial research and development.
8. Any other activities to promote generally the objects of the resolution.

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The Ministry of Education provides the administrative link between the Government of India and the Council.

2.2. Administrative Structure

The CSIR is administered by a Governing Body of which the Prime Minister is the President, the Minister for Education the Vice-President and the Director General of CSIR the Principal Executive Officer. The Governing Body (1964-65) consists of 35 members composed of 11 Ministers of the Central & State Governments, 11 scientists, 9 industrialists and 4 officials of the Central Government. The Governing Body is advised by the Board of Scientific & Industrial Research consisting of 43 members composed of 6 Ministers of the Central and State Governments, 28 scientists and 9 industrialists.

The Board advises the Governing Body on proposals for instituting specific research, study of problems affecting particular trades and industries, establishment of research institutes, and award of fellowships as an essential preliminary to systematic investigation in particularly important fields of research.

The Board and Governing Body are assisted in their work by a joint Sub-Committee of the Governing Body and Board and a Finance Sub-Committee who scrutinise the technical and financial aspects of the proposals.

The Board is also assisted by the following Research Committees.

1. Physical Research Committee
2. Radio Research Committee
3. Chemical Research Committee
4. Geological & Mineralogical Research Committee
5. Pharmaceuticals & Drugs Research Committee
6. Metals Research Committee
7. Biological Research Committee
8. Electrical & Mechanical Engineering Research Committee
9. Civil Engineering & Hydraulic Research Committee
10. Aeronautical Research Committee
11. Joint Committee of Indian Central Oilseeds Committee and CSIR

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2.3 Headquarters

Administrative coordination and planning is carried out at the headquarters of CSIR at New Delhi, where the offices of the Director General are located. The secretariat consists of the Secretary, Deputy Secretaries and Under Secretaries and various other officers. The following scientific and technical units are also located at the headquarters :

1. Survey and Planning
2. Research Coordination, Industrial Liaison & Extension
3. Defence Coordination
4. National Register

5. Publications & Information Directorate
6. Central Design & Engineering and
7. Patents

A brief description of the activities of these units is given in Chapter 9.

2.4. National Laboratories and Institutes of the CSIR

The Council administers 29 Research Laboratories and Institutes which include two industrial and technological museums, an Indian National Scientific Documentation Centre (INSDOC), Organisation for Medicinal Plants Cultivation, a Central Scientific Instruments Organisation and the Indian Ocean Expedition. Some of the Laboratories/Institutes have field stations located in different parts of the country. A list of these laboratories with their year of establishment and names of their principal executive officers are given in Appendix II.

Each Laboratory is under the control and general direction of an Executive Council consisting of scientists, industrialists and government officials. The Executive Council, assisted by a scientific sub-committee and a buildings and finance sub-committee, is responsible for the framing and approval of the research programmes, determining the strength of the staff and formulating the budget within the frame-work of the rules and regulations and directives issued by the Governing Body.

Growth of research activity under the Council has been rapid in the recent years and a comparative table showing the position in 1947, 1954 and 1963 is given below:

Year	*Total number of Laboratories/ Institutes*	*Budget (million Rs)*	*No. of scientists/ technologists*	*Total number of employees*
1947-48	2	5.26	70	Not available
1954-55	12	21.7	542	2993
1963-64	29	117.5	2435	11319

The year-to-year growth of activity of the Council for the period under review is shown in Appendix IV and V.

2.5. Co-operative Research

The Council promotes user participation in research by financially supporting Co-operative Research Associations of Industry. Capital and recurring expenditure up to 50 per cent is borne by the CSIR, the rest being subscribed by the industry. The Council also helps by way of technical advice,

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preparing of plans, framing of rules and regulations, and procuring of materials, equipment and experts where necessary. Three such Research Institutes exist in the textile industry, and one each in the silk, tea and plywood industries. Similar institutes for paints, rubber and cement are in the planning stage. During 1963-64, financial support of Rs 1.92 millions was provided to these Research Associations. A list of the Cooperative Research Associations of Industry, their year of establishment, principal executive officers and details of financial support provided are given in Appendix III.

2.6. Grants-in-aid, Fellowships and Foreign Training

The Council provides grants-in-aid for research in universities and scientific and technical institutes and laboratories outside the CSIR through the Research Committees under the Board (see 2.2.). These are in the form of research schemes providing for senior and junior fellowships of Rs 400 and 250 per month respectively (Rs 500 and 300 for Engineering subjects), equipment and other expenses. During 1963-64 the Council is supporting 518 research schemes at an expenditure of Rs 5.4 million as compared to 110 in 1954 at an expenditure of Rs 0.8 million. Besides these, the CSIR sponsors a large number of Senior and Junior fellowships available to promising younger research workers in the universities and other institutes. The CSIR also gives financial support for setting up of research centres, e.g. for Dye-stuff Technology at the Bombay University and for Earthquake Engineering at the Roorkee University (see Appendix V).

Facilities for higher training and research in specialised fields are provided by deputation of research workers to institutes in scientifically advanced countries. Advantage is also taken of international fellowships and scholarships offered through scientific and cultural agreements with other countries and schemes for fellowship and training instituted by Burmah Shell, Assam Oil Co. and ESSO in Commonwealth countries and the USA.

2.7. Collaboration with Other Organisations

With the growth of scientific activity and the setting up of a large number of organisations dealing with teaching, research, technical training and development in different fields, planning of liaison and collaboration between the institutes of the CSIR and other organisations becomes one of the important and strategic functions of the Headquarters. Relations with the Universities and Institutes of Higher Technology and contacts with the Indian Council of Agricultural Research, Indian Council of Medical Research, Railway Research and Designs Organisation, Atomic Energy Commission, Defence Research and Development Organisation, Indian Standards Institution and others are initiated and developed at all levels, at the Headquarters and at the laboratories. / The best form in which collaboration with these organisations can be developed to mutual advantage in future will be determined as a result of experience.

2.8. Collaboration with International Bodies

The Council participates in the international research projects such as those connected with the collection of ionospheric data and the

International Geophysical Year. It is a participating member of the International Council of Scientific Unions. The Radio Research Committee functions as the National Committee in India for the International Union of Radio Science. Problems of theoretical and applied mechanics are referred to the Council by the International Union of Theoretical and Applied Mechanics. The INSDOC represents India on the International Federation of Documentation.

The Council is the executing agency on behalf of the Government of India for Science Exchange Programmes for Agreements with other governments and Academies of Sciences such as the USSR Academy of Sciences, Hungarian Academy of Sciences, Polish Republic, Federal Republic of Germany, German Democratic Republic, United Arab Republic, etc.

Schemes financed by the U.N. Special Fund, Colombo Plan, T.C.M., UNTAB, Ford Foundation, etc. are in operation in some of the laboratories.

2.9. Technical Manpower

Data and information on the availability, and on the future potential requirements of scientific, technical, engineering and medical personnel in India are continuously collected and maintained by the National Register. The Unit has a section for Indians abroad with information about their training and specialisation. Temporary placement for Indian scientists/technologists returning from abroad is provided by the Scientists' Pool. In this, salaries ranging from Rs 400 to 700 or above are awarded to selected candidates till they are absorbed in regular employment. During 1963-64, 859 scientists were selected to the Pool which has served a useful purpose in attracting Indian scientists to return from overseas to serve their country.

2.10. Communication of the Results of Research

Communication of the results of research by the CSIR laboratories is through presentation of research papers at symposia, seminars and through publications in research and technical journals. Such results as are of patentable nature are protected through Indian and foreign patents. The Council publishes the following journals through its Directorate of Publications and Information:

1. Journal of Scientific & Industrial Research
2. Indian Journal of Pure and Applied Physics
3. Indian Journal of Chemistry
4. Indian Journal of Technology
5. Indian Journal of Experimental Biology
6. Indian Journal of Biochemistry

It also publishes a journal dealing with research pertaining to industry entitled 'Research & Industry', a fortnighly bulletin named 'CSIR News' and a standard encyclopaedia, the Dictionary of Indian Raw Materials and Industrial Products, under the popular title 'Wealth of India'. In Hindi, it publishes *Vigyan Pragati* to provide technical information to small scale industries. Recently the CSIR has started the publication of a science journal titled "Science Reporter" for dissemination of scientific information.

The National Register Unit publishes a monthly bulletin entitled "Technical Manpower" giving information on scientific and technical personnel. The Research Coordination, Industrical Liaison and Extension Unit issues a quarterly 'Information Newsletter' containing abstracts of the research carried out in various national laboratories of use to industry.

Some of the laboratories also publish periodic bulletins or newsletters in their fields of specialisation directed to industries in their field.

Publicity is handled by a Publicity Officer who also issues periodic press statements on the achievements of the CSIR and its laboratories.

2.11. Utilisation of the Results of Research

For industrial utilisation of the results already tested on pilot plant scale, the Central Design & Engineering Unit of the Council undertakes project evaluation, engineering design, procurement, erection and commissioning of industrial plants based on processes of the CSIR laboratories. Contact with industries and associations of industry is maintained through Industrial Liaison Units of the laboratories who convey information on completed researches to industry and feed back industry's problems requiring investigation to the laboratories. Their efforts are supplemented by the Research Coordination, Industrial Liaison and Extension Unit at the Headquarters which maintains contact with government organisations for planning and industrial development, the Ministry of Industry and other user government departments. Arrangements for exploitation by the industry of the patents and processes developed by the CSIR are usually handled by the National Research Development Corporation, who also sometimes finance pilot plant, semi-commercial and prototype units.

2.12. Planning & Expenditure on Research

Studies on expenditure on Scientific Research and determination of fields where investment on research would be more fruitful are undertaken by the Unit for Survey & Planning of Scientific Research at the headquarters, who also collaborate with the Planning Commission in the formulation of perspective plans for the research work of the Council.

Funds of the Council are almost wholly derived from the Government, a small portion coming from donations from some industrial houses and income by way of royalties and premia on the Council's processes. As seen in appendix IV, the total budget of the Council increased from Rs 21.7 million in 1954-55 to Rs 117.5 million in 1963-64.

CHAPTER 3

TECHNOLOGY AND THE PROBLEM OF INDIA

3.1. Statement of the Problem

It is a tribute to the foresight of the late Shri Jawaharlal Nehru, the then Prime Minister of India, that science in the country has been actively fostered and encouraged, in appreciation of its role in industrial and economic development. In a brief period of 17 years, 29 research institutes and laboratories have been set up dealing with major disciplines in science or specialising in research bearing on major fields of industry. India can be proud of its research institutes which represent a national asset of major importance. In adapting research to Indian conditions, and utilisation of indigenous raw materials they have already made significant contributions to industrial progress, which will increase greatly in years to come. More than 2,000 research and technical personnel, some of them highly qualified and trained in countries abroad, are playing a significant role in the country's future development as a modern industrial State. Costly and specialised equipment, instruments and pilot plants have been set up and well stocked scientific and technical libraries and documentation services established. In spite of all this a truly formidable task lies ahead.

Over two-thirds of the population of India live on less than one rupee per day. This is insufficient to give the necessary strength and energy to lift themselves up out of this level. Every day there are 25,000 more mouths to be fed. These are not just shock figures but describe realistically the basis of the largest social and economic problem in the world today. And this has happened to a country which once was in the van of civilisation and in a world which on the whole is moving forward at a tremendous pace.

India is not a poor country so far as natural resources go, even if it is not as rich as many. It has a fertile soil and a plentiful if spasmodic rainfall. It has good mineral resources: iron ore, aluminium ore, coal, building materials and many others which remain to be exploited. India's main problem is to gain knowledge of technologies required to utilise its natural resources, and to organise this knowledge and the efforts of her poeple to build up the tools and equipment to enable a day's work to produce an adequate return.

3.2. Scientific and Technical Potential

Today, there is far more technical knowledge in the world than would be necessary to lift India out of her present state. To make this available would require both a system of communication and one of education of vast complexity. The flow of know-how depends as much on the capability of the receiving end as on the willingness of the despatching end. This means that India must have throughout her industry, agriculture, health services, etc. men who can organise and translate the know-how into action. Because of the highly specialised nature of this knowledge, she must back up these men by centres manned by people of high competence and equipped with the necessary facilities. The scientific and technical potential available and required in India today must be viewed in this context. Fortunately, India has today a growing number of people with knowledge, foresight and above all dedication.

3.3. Foreign Know-how

There is one channel of flow which is of special importance and that is through collaboration with more advanced technologies of foreign countries. This channel is an efficient one and is by far the quickest for the specialist knowledge of manufacture as the flow is directed to the point where it is made use of. Even in advanced countries the flow of know-how between nations plays a very major part. The maintenance and improvement of such channels of flow with due consideration of other consequential problems are essential to India's move forward. ***But this is not enough.***

While facilitating a judicious inflow of foreign specialist know-how India must build up its own specialist kowledge and learn to overcome its large dependence on foreign know-how. Indian research centres must attack India's own problems, problems associated with the special characteristics of her soil, agriculture, natural resources and sources of energy together with special abilities of her people.

3.4. Indian Democracy and Planning

India has decided to move forward under the democratic system, and its leaders are engaged in the endeavour to produce a social organisation to give order and stability to the sub-continent. India has chosen the democratic path as the system compatible with her way of life and thought. Success depends on many factors of which only one is central to this report, *viz.* the application of technical knowledge and the creation of necessary new knowledge through research.

To set the pace of development and maintain a balance in this great move forward, India has decided upon planned development through a series of 'Five Year Plans'. The Planning Commission, as the instrument for planning on the basis of available technical and economic data, decides upon the rate of growth of the economy, allotment of priorites and the fixing of targets for production in agriculture, industry and other sectors and the overall deployment of resources for maximum achievement in keeping with the social objectives. The programmes of scientific and industrial research must be related to the targets, objectives and emphasis of the country's present Third Plan and of the Fourth and Fifth Plans. Just when a mid-term appraisal of the Third Five Year Plan has been made and planning for the Fourth Plan is in progress, it is particularly opportune to make an appraisal of the trends in Indian research and plan its orientation to further the country's development.

3.5. National Income & Expenditure on Research

Although per capita expenditure on scientific research in India has shown a steady increase over the years, it is a long way from being anywhere near that being made by the more advanced countries. Tables 1 and 2 give an idea of the growth of expenditure on scientific research in India and its comparison with other countries.

3.6. Scientific and Industrial Research

Research is a process for creating new knowledge or for converting existing knowledge into a more usable form. It is obviously both the starting point for progress and an essential part of the follow through. This has been realised from the early days by the builders of India and particularly those associated with the Central Government. The emphasis on research has led to the building up of research organisations and laboratories which in some cases can match those to be found anywhere in the world. As this report will show, much more remains to be done and certain changes of balance should now take place.

The main change required is an increase in the ratio of applied to 'pure' fundamental research. The second world war brought the scientists and technologists into a prominent and responsible position in society. To some extent this has happened in India also.

While the Indian scientific community has an appreciation of the economic situation of this country, it is necessary to remind them of the magnitude of the problem. They need to bear constantly in mind the urgency of getting to the 'take off' point, where the economy generates enough savings to cope with the country's investment, enough exports to pay for its imports, enough educated people both technically and otherwise to meet the needs including those of educating others—all this without massive outside aid. It is necessary also to appreciate that this take off point keeps rising as the economy of the outside world goes up and that India is at present not catching up with it. It is encouraging, however, to know that the going becomes easier the closer one comes to the take off point. What is required, therefore, is *an immediate spurt of effort* to overcome the many problems of India.

One of the lessons of the Second World War was the remarkable way in which scientists who had spent their lives in pure research were able to change over to applied work or to fundamental work associated with practical problems and to make enormous contribution to their countries' needs. All this was achieved, not by coercion but my motivations based on appreciation of what was required of them. This is already happening in India but it must happen to a much greater extent.

3.7. The Planning of Research

In addition to the change in balance, there needs to be a rapid growth in the total volume of research. The Government of India have set up a number of organisations to meet many of the country's needs. The organisations cover the fields of agriculture, industry, medicine, atomic energy,

TABLE 1—Per Capita Expenditure on Scientific Research and Proportion of Expenditure on Scientific Research to National Income in India

Year	*Population* (millions)	*Total expenditure*		*Per capita expenditure*		*National income of India at current price level* (million Rs)	*Percentage of research expenditure to national income*
		Current price level (million Rs)	1952-53 price level (million Rs)	Current price level Rs	1952-53 price level Rs		
1952-53	372	121.9	122.9	0.3277	0.3277	9,820	0.12
1955-56	387	189.4	204.8	0.4894	0.5292	9,980	0.19
1957-58	397	267.7	247.0	0.6743	0.6222	11,390	0.24
1958-59	402	314.1	278.3	0.7813	0.6923	12,600	0.25
1959-60	425	379.3	324.0	0.8924	0.7624	12,940	0.29
1960-61	436	412.6	330.6	0.7583	0.7583	14,160	0.29
1961-62	440	469.1	375.0	1.0661	0.8523	14,630	0.32

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TABLE 2—Per Capita Research Expenditure and Per Capita National Income in Various Countries

Country	*Year*	*Expenditure on scientific research* (million) Rs	*Population* (millions)	*Per capita research expenditure* Rs	*Per capita national income* Rs	*Research expenditure as per cent of national income*
USA	1961-62	72,580	174	410	14,190	2.9
UK	1961-62	8,467	52	162	6,010	2.7
Sweden	1961-62	1,088	7.4	146	8,649	1.7
India	1961-62	469	440	1.07	334	0.32
China	1960	2,000	669	3.00	—	—
Australia	1958-59	400	9.9	40	5,780	0.70
Norway	1958	124	3.5	35	4,540	0.70
Yugoslavia	1958	76	18	4.20	1,810	0.22
USSR	1958-59	20,700	209	99	3,303	3.00

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defence, railways, posts and telegraphs, etc. and in most cases they have grown in a remarkable and effective way. With so many agencies in the field, it is necessary that there should be proper coordination between them to avoid unnecessary duplication of effort, and to locate the areas where effort may be concentrated in keeping with the nation's requirements. A system of inter-communication and exchange of information between research organisations belonging to different ministries is necessary to enable them to play their full part in the country's scientific effort.

3.7.1. Fortunately India has a highly developed organisation, the Planning Commission and a number of government departments to put its Plans into action. The field of work covered by the Council of Scientific and Industrial Research would benefit in many ways by a closer liaison with the Directorate General of Technical Development and the Ministry of Industry. There are many directions in which CSIR can closely cooperate with other organisations but the links with the departments and ministries responsible for planning and setting out and execution of policies for industrial development are of paramount importance. The extent of effort required, purposeful direction of industrial research as an aid to industrial development and the long-range planning of research in national perspective would need the close association of CSIR with these departments in the framing of its programmes.

3.8. Research and Industry

With a few striking exceptions, industry in India, whether public or or private is less research minded than industry in the countries which have advanced as a result of science and technology. It is a paradox in all countries that backward industries are commonly those which both are unwilling and do not know how to progress. In India industry generally is labouring under many problems—shortage of raw materials, shortage of foreign exchange, etc. These so dominate many industrialists' thoughts that they have little time to tackle the problems of making a change in their operations.

Demand for most of the products of industry is far greater than its present capacity to supply. In such a situation, there is hardly any incentive to improve the quality of their products when they can sell everything they can produce. In the absence of any mutual competition, there is little desire to utilise research even to outpace the rivals in the field.

Industry is also disinclined to make use of indigenous know-how in competition with foreign know-how specially when the latter is in a position to offer technical and economic guarantees and financial participation. It is yet to acquire the discriminating wisdom of taking reaonable risks in cases where Indian know-how may be able to supplement a foreign process or even to improve upon it.

The charting of the road to be followed to get out of this situation is one of the objects of this Report.

3.9. Research and Government Departments

The situation regarding the fields of responsibility of many Government Departments is not very different from that of industry. The training of administrators does not yet include the skills to bring about changes, let alone stimulate and guide active research organisations.

3.10. Research and the Universities

In India which is trying to pass through an industrial revolution, there can hardly be a surplus of skilled scientific and technical personnel. Various research organisations and industries are in competition for the limited numbers turned out by the universities and technical institutes. In some specialised fields such as chemical engineering, engineering, metallurgy, and fuel technology, the dearth of scientific personnel is particularly acute. To some extent it has resulted in the lowering of standards of talent available for research. At the same time due to rapid expansion in the number and size of the research organisations, the universities and teaching institutes have been denuded of their senior teaching and research personnel. This is a most serious development for it affects the main flow of technical talent for the entire system.

Some steps appear to be necessary for a partial reversal of this process and Council's assistance must be forthcoming for a strong support for the drive to improve the scientific and technological work of the universities and thus ensure an adequate supply of technical manpower.

3.11. Research Programmes in the Institutes

The coverage by research of the field of India's problems is on the whole reasonable, but some points need much increased emphasis. The control of the growth of population is the outstanding problem of the day and every ounce of effort that could usefully be put to solving this problem should be so oriented. Agriculture is the next most important and here CSIR could give much more help than at present. Balance of payments is also a key problem. A large fraction of the effort of CSIR is rightly put to problems of import substitution; but increased exports is in the long term a more secure approach to the payments problem and an increase in effort in this direction should be undertaken.

Objective and applied research by its very nature must be planned—its objects must be found and clearly stated. On the other hand research cannot be planned like production. Ideas cannot be turned out to order. Progress is made by setting up laboratories with the necessary facilities manned by scientists and engineers with the necessary specialist training, by surrounding these men with an atmosphere conducive to creative thought and by directing their attention to a particular area of the country's needs.

CHAPTER 4

EVIDENCE AND COMMENTS

In this chapter an attempt is made to summarise the many comments which the Reviewing Committee have received from various sources including those listed in Appendix I. Some of these were expressed in a critical manner but often the people concerned were unaware of changes which have recently been made by the Governing Body of CSIR in its meetings held in November 1963, and March 1964. It should be re-emphasised at the same time that there is a widespread appreciation of the fact that CSIR has built up a series of laboratories and a coordinating servicing headquarters which has made and will continue to make a major impact on India's problems. The Reviewing Committee's task, however, was not just to record the successes but to seek out the problems and suggest possible lines along which solutions might be sought. The views in this chapter are quoted without comment, but most of them are dealt with later in this Report.

4.1. Industry's Views

The responsibility for the move forward for most of the economy other than agriculture, lies with the people in industry both private and public. The obstacles to be overcome in increasing the quantity and improving the quality of the goods and services they produce are enormous. The shortage of raw materials and of technical personnel, restrictions on imports and on capital investment, to mention only a few, lead to frustration and delay. Most industrialists appreciate the necessity for a balancing of exports and imports but produce arguments why the restrictions should be relaxed in their own case. Fewer industrialists appreciate that control of capital investment is necessary if inflation is to be avoided; because such investments tends to increase domestic purchasing power before it becomes productive.

When industrialists were asked why they have not extended or modernised their plant or increased their efficiency, some in addition to the above reasons, quoted problems associated with trade unionism or government restrictions leading to inflexibility in labour. There is clearly a conflict between the two objectives of increasing efficiency and of producing more jobs.

The industrialists interviewed were chosen because of their knowledge of the CSIR laboratories and, therefore, were people with some knowledge at least of how progress is made through research. Their common complaint was that they could make little or no use of certain of the national and central laboratories of CSIR. The reasons given for this failure were various:

i. There was insufficient consultation with industry in the setting up of the programme.

ii. The Executive Council was too large and comprised of highly placed busy persons with little time to scrutinize and advise on proposals largely leaving it to the director to formulate and divide the programme.

iii. The closer contact with industry necessary at the pilot plant stage was lacking.

iv. The laboratories did not carry a project far enough; it should in their view be taken to a proved commercial stage.

v. Some of the laboratory directors or staff claim for their results more than what is justified.

vi. Facilities for design of plant and equipment to carry out a new process did not exist in the country.

vii. The results of research work emerge much too slowly. Before a solution is proposed by some CSIR laboratories, it will have been necessary to seek some other solution.

viii. Too large a proportion of the work of some laboratories was taken up by fundamental research, unassociated with any industrial problem.

ix. There should be more sponsored work in the laboratories.

When asked why they did not set up laboratories of their own, some industrialists contended that it did not pay. Others pointed out the difficulties of getting the necessary qualified staff and of financial resources for setting up of research establishments.

4.2. Scientists' Views

The responsibility for action to attack through research the many technical problems of industry lies with the scientists and technologists, and they are mostly found in or associated with CSIR organisations. Some of the laboratories have very close links with industry and have had remarkable success at getting their results utilised. Others are very dissatisfied with what industry had done to use the results of their work. There is a belief that a large part of Indian industry is not interested in research, that it lacks the spirit of adventure and the capacity to take a calculated risk necessarily involved in utilising indigenous research. The complaint is that it was more interested in collaboration and obtaining technical know-how from abroad which should mean quick returns and guaranteed profit.

A lack of proper coordination with the machinery for industrial licensing and planning has given the feeling that Indian research is being bypassed and made unfruitful.

Much evidence was produced to support this contention. At the best a company would agree to take over a process provided every element of risk was removed by the laboratories carrying the work far beyond the pilot plant stage [see para 4.1 (iv)].

The problem of finding a company to be the first to try out a new process is found in every country. The 'first' has all the headaches, whereas the second and later ones take on a smoother running process. It was felt that the Government could help here by giving some sort of guarantee to the first applier of an Indian process.

The main problem as seen by the research institutes is to find an organisation or organisations that will convert the pilot plant results into a working project for a manufacturer to operate. There are few plant manufacturers in India and those that exist need to concentrate on conventional plants. There are still fewer design and engineering units or consulting engineers and, if an institute or prospective manufacturer goes to a consultant abroad, the latter would be happier to recommend processes with which he is familiar rather than risk something new. Know-how may be a comparatively smaller component of the investment on machinery and equipment. This problem of the missing link between the pilot plant stage and production is solvable in fields such as ore and coal beneficiation, metallurgical processes, and in respect of equipment in fields such as cement and boilers, but over a very wide field of the activities of CSIR, it remains a serious obstacle to the utilisation of the research results.

In other directions, the biggest problems facing the research laboratories are those concerning staff and especially of recruiting people from the universities with the right specialised knowledge. Another is the availability of foreign exchange for essential tools for research. These problems are dealt with in a later chapter and the only thing that need be said here is that most directors would welcome a greater degree of decentralisation of responsibility.

One occasionally hears criticisms of universities on the grounds for example that they do not train people in the specialist skills required by certain laboratories. It is also thought that certain university staff neglect the opportunities for fundamental research and aim at applied research for which they are less favourably placed.

4.3. University Scientists' Views

Most university teachers agree that basic research is their function and are unhappy that in fulfilling this, they are hampered by numerous difficulties. Perhaps the most important problem is absence of equipment necessary for modern research. Acquisition of Indian made equipment is difficult enough but the standard and reliability of such equipment in many cases is low. The delays and problems in getting foreign made equipment are, of course, enormous but the situation is made much worse by the absence of facilities to maintain the equipment. The more complicated pieces of equipment, obtained at great trouble and cost, often lie idle because of a missing part or lack of the skill and knowledge to put the fault right.

There is general acknowledgement and appreciation of the CSIR scheme of research fellowships for post-graduate research, and the substantial increase in their number during the recent years. This has helped many young persons to stay on in scientific research and make it a career. It has also enabled the universities to maintain a concentration of effort in certain fields of research.

4.4. General Comments

The Committee frequently came upon a major problem and one which besets any country, i.e., how to encourage an industry to be progressive. The major factors promoting use of research are, improvement in quality or reduction in cost of existing items of manufacture, the possibility of introducing newer or substitute products or processes, or the possibility of utilising other raw materials than the traditional, all of which must eventually lead to better profitability. However, there are many external factors which affect these objectives. In India there does not seem to be adequate pressure towards either cost reduction or improvement in quality or to discover newer products although there is pressure to use substitute materials. The economy seems to have provided in most cases a sheltered market which militates against improvement normally necessitated by competition.

In this context the licencing operations of the Government of India also came under discussion. It was represented that it would not be advisable to use the machinery of licencing to exercise compulsion in favour of adoption of processes worked out by the national laboratories in preference to know-how that an entrepreneur might desire to obtain from abroad. Since the establishment of industry involves investment of large amounts of capital, the freedom to the industrialist to choose the process in which he may have greater confidence could not be restricted. It was pointed out that the limits placed upon the licensed capacity may indirectly create a sheltered market, thus creating a disincentive in respect of utilisation of research. It was felt that in licensing the policy should include the creation of internal competition but it was stated that this was usually taken into consideration. A view was advanced that it might be useful to impose a levy of some kind on industry for providing finances for research. However, it was argued that any compulsion of this type would not be desirable.

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Part II

CHAPTER 5

GENERAL PRINCIPLES

This Chapter outlines the general principles underlying our detailed recommendations.

5.1. CSIR

Council of Scientific & Industrial Research is the largest organisation of civilian research in India. Because of its activity in different spheres through its laboratories and institutes in different parts of the country, it has become a symbol of the country's march to a modern industrial state—an investment and hope for the future. A great deal has been fulfilled but much more is expected.

The original functions assigned in 1942 to the CSIR were all embracing in the matter of initiation, promotion, coordination and guidance of all scientific and industrial research. However, with the increasing activity and scientific responsiblity of organisations such as the Indian Council of Agricultural Research, the Indian Council of Medical Research, Department of Atomic Energy, Defence Research and Development Organisation, University Grants Commission, and research establishments of other ministries in their respective spheres, it is pertinent to ask if the functions of the CSIR require to be redefined.

For reasons of efficiency of operations and management, as well as preservation of a healthy dynamism in the structure of research activity, there are bound to be a multiplicity of agencies and organisations engaged in specialised scientific activity. The larger the number of such agencies, the greater the need for overall planning and coordination by an agency which provides a national perspecitve to scientific research and development efforts. The task of evolving a strategy for science and technological research as a whole for the entire nation is important. The responsibility for an agency for this purpose must clearly rest with the Government. Whatever be its nature, this agency must have at its disposal all the data and information essential for planning.

For the purpose of planning of the research programmes of its own laboratories the CSIR would have to increase both the degree of rigour as well as the scope of collection, survey and analysis of information on scientific and industrial research. Considering the spread of the Council's work, it is essential that the framework of consideration and scale of this operation should be as wide as possible. This data and planning has relevance to the rest of the scientific and technological activity in the country. Thus, CSIR has an important role to play in providing data and information which would be of invaluable assistance in the framing of a National Science Policy.

5.2. Governmental Responsibility for Research

CSIR and its laboratories enjoy an autonomous status though its funds are derived almost entirely from Central Government sources. In most of the developed countries, the responsibility for industrial research lies primarily with the operating companies both private and public. However, even in these countries, government supported research plays an important part and is on the increase. The reasons for the Indian government playing a major part in technological and scientific research are similar to those in developed countries but are many times stronger. In no other way could the pace of progress come any way near to what is necessary. In developed countries this argument is generalised into the simple statement that the economic 'defence' of a country is just as much one of governmental concern as is the military defence. In India the concern is with economic survival.

Only by a government organisation for scientific and technological research can the degree of inter-communication and coordination be provided which can markedly increase efficiency especially in a country which is limited by its supply of research manpower and facilities. Industry in India with few exceptions has not been engaged in research largely because of its recent origin. In the circumstances there is every reason for the government, mainly through CSIR, taking on a large range of activities, while continuing to press the industry to do its duty. However, research because of its nature will not thrive unless it is kept free from administrative procedures that usually go with government departments.

5.3. Flexibility in Function

As is seen from Chapters 2 and 3, the range of activities under the Council have been varied and flexible. It has helped to step up activity where it was most needed, given a helping hand and imparted strength and stature to research organisations otherwise languishing for want of funds and encouragement. It has filled in the gaps in science, technology and their social aspects which existed in the absence of any agency capable of shouldering this responsibility. *This flexibility in functioning remains necessary and the Council should continue to be able to take up any type of activity in the field of science lacking a sponsor.*

Earlier it has been emphasised that CSIR must keep a watch over the whole field of India's scientific and technological problems and be prepared to put in effort where needed. As a corollary to this and in view of a well-accepted axiom, that the maximum use is made of research when it is as close as possible to the user, CSIR should continually press for user participation. Sometimes the 'user' is represented by another government department such as the Ministry of Health, of Works & Housing and Supply and of Transport. The form of participation required is not just representation on the executive councils; it is a joint responsibility for parts of the research programme, for identification of objectives, for continued guidance to the research workers and finally for overcoming the problems of application. The responsibility is best made clear by the transfer of funds on some form of percentage basis and/or in the form of a contract.

Indeed this corollary might in certain cases well be carried further. Where a government department has an agency which is able to maintain the conditions necessary for creative work, consideration should be given to the taking over of the major responsibility for a laboratory by that agency. For example, the Indian Institute for Biochemistry & Experimental Medicine would be brought closer to the users of its results, if it were transferred to the Indian Council of Medical Research. Similarly, the Coal Survey Stations might be transferred to the Coal Board. In such cases, links with CSIR could profitably be retained.

5.4. Classification of Research

Scientific Research can be broken down into various classes.

i. "Pure Basic", where the object is mainly advancement of knowledge.

ii. "Applied or technological" where the object is clearly envisaged in terms of a new plant, process product or service, and

iii. "Objective basic" which is to provide knowledge on which to base technological advances.

"Pure basic" research is important to India for several reasons. It is the principal source from which major departures from orthodox practice arise. By its very nature such research must be up to world standards and the firm establishment of such standards in India is essential to the maintenance of a high level in all types of research. Finally and perhaps the most important reason concerns teaching. University teachers train people for the future and their students not only must know what is the proper standard of research but must also in some fields at least be thoroughly up-to-date. This is one primary reason why pure basic research and universities are normally found together. The other is that pure basic research thrives better in the atmosphere of a healthy university where it does not have to be related to economic objectives.

5.4.1. The fact that technological research, the major responsibility under CSIR, is essential to India needs no supporting argument. Its success is to be measured by the contribution it makes in the national economy, in other words the use made of it. Its closeness to the user, which means the people, as organised into communities, factories, States or unions of States is essential to its application. Indian industrial companies have yet to go a long way in undertaking research and developmental activity on their own and in making greater use of what is done in government laboratories. They mostly depend on research carried out elsewhere for which they pay in the form of fees and royalties. Such technological research as is carried out, is mainly through CSIR, and includes even those activities for which industry should be taking responsibility. It is interesting to note that those industries such as textiles and jute manufacture which export into the competitive world market do take a large responsibility for research.

5.4.2. It has been established that research supported by the Central Government can produce an atmosphere conducive to creative work. Nevertheless the administrator who can create such an atmosphere is rare.

One is faced with the conflicting principles that on the one hand the best research is carried out independently of the user, but the best application of research occurs when it is as close as possible to the user. In accordance with these principles, a research department in an industrial company must be protected from day to day problems and allowed to develop its own atmosphere. A centralised research laboratory on the other hand must take positive steps to ensure its links with the user. This last is one of the biggest problems of the CSIR laboratories. Getting an industry in India to take on its share of responsibility is a difficult problem. Whatever may be the reasons the fact is that all possible use has not been made of the researches carried under the CSIR. The ways in which it has been or could be achieved is discussed elsewhere.

5.4.3. While "pure basic" research should primarily be left to the universities, "objective basic" research undertaken in order to fill a known gap in basic scientific knowledge in a field of potential practical importance or to extend the area of understanding and application of an industrial process, should be of primary interest to the CSIR laboratories. Standing as it does between the two extremes, of "applied, developmental and project research" on the one hand and "pure basic" on the other "objective basic" research needs workers of the highest calibre who are a combination of the intellectual with the practical. This type of research is not mere routine and must be provided with the facilities, atmosphere and treatment requisite for all creative work.

5.5. World Science and Indian Research

Scientific and technological research in India, in the modern sense is comparatively recent. The total number of scientists, and scientific and technological and teaching institutions and the volume of activity will have to grow rapidly and diversely to provide the base and the support for economic growth. As the outlay that the country can afford may not compare with scientifically and technologically advanced countries for a long time to come, the planning of research must be such as to ensure maximum returns on investment in terms of practical results achieved. India has the advantage here in that she can draw upon the world's accumulated and growing scientific and technical knowledge, experience and information. It would be wasteful to re-do what has already been done elsewhere. *For quick results Indian science and technology must catch up at an advanced stage and go on from there.* But even for this it will require scientific and technical personnel of the highest calibre, supported by well-equipped institutions. Equally essential will be for it to build up a healthy scientific tradition and a scientific community capable of enforcing standards of personal and professional integrity. The younger scientist will have to be given encouragement and appreciation by his senior colleagues and the freedom and atmosphere to make the maximum use of his creativity.

5.6. Planning and the Formulation of Research Programmes

The formulation of research programmes can best be considered in relation to two distinct phases, the institution of new ideas and the follow through of a selected number. The first phase requires a high degree of flexibility and facilities for quick exploratory work. Planning here consists of maintaining a constant impact on scientists in the laboratory of the problems of the industry which they serve or of that part of the Indian economy with which they are concerned. The intermingling of a knowledge of problems with a knowledge of science is what generates new ideas.

At present research programmes of the institutes are inevitably based on ideas arising mostly internally with the director and the research staff. A lacuna arises in a lack of impact of ideas from people outside. The position can be improved by contact with departments of planning and industrial development, familiarity with the short term and long term programmes and problems of industry and association of scientists from industry in the framing of research programmes. This would also enable forward thinking and anticipation of the research requirements in their relation to the plans of industrial development. Research is a slow process and may take years to produce results of a nature and in a form capable of utilisation.

We have repeatedly emphasised (for example, see 3.7) the need for an intimate association of the Council, its laboratories and its scientists with the planning process, and we are glad to learn that additional steps have recently been taken in this direction. However, planning in India, which bases itself on targets of expenditure or production for the major industries only, is insufficiently detailed for the purpose of research planning. The latter requires more information on imports and exports broken down more finely among the various industries. It also requires the screening of such information in the light of technical facilities available or possible of development within the country.

We would recommend that CSIR in collaboration with the Planning Commission and the Directorate General of Technical Development, introduce what further steps may be necessary to achieve this end. It will be necessary for many of the government Departments concerned to make available the information in sufficient detail for programming research.

We were surprised to find how few of the Directors and senior staff of the various laboratories were sufficiently alive to the contents of the current Five Year Plan. The main background of each of the Development Plans, together with the relevant parts of the detailed information, must go regularly to the senior staff throughout the CSIR. This should be one part of the mechanism to maintain that 'constant impact' referred to at the beginning of this section.

5.7. Formulation of Research Programmes : Second Phase

The more serious problem is in the second phase, the selection of those ideas that should become projects and which form the bulk of the programme for any laboratory. It is important to strike a balance between spreading resources over too many projects and at the same time to avoid missing something that could be quite important.

5.7.1. It is usual to base the priority of a project on a combination of two major considerations, the need of the result envisaged and the promise of achieving such a result. The assessment of the first should be done by full consultation with the potential user by comparison with the current and the next Development Plan and by a preliminary study of the economics and the alternatives. No industry would take up a process, however interesting and novel, if it does not offer an economic advantage.

The promise involves a technical assessment by the scientists in the institute bearing in mind their knowledge of the background science and engineering concerned and the potentialities of their staff and facilities. Such an assessment should include a time by which the project can be expected to reach a certain stage or its final conclusion, to avoid the risk of being out-stripped by competitive work elsewhere. There are obviously other considerations in the overall allotment of priority, such as whether it would be quicker and cheaper to import knowledge from abroad.

Applied research including objective basic, can and should be planned to a substantial extent if maximum success is to be achieved. This does not mean highly centralised control, but rather that the guidance on policy should be handed down from directors to their staff and the objectives of each project clearly studied, defined and agreed between them. A tentative time schedule could be drawn up simultaneously. Once this is settled, the project leader and his team should have sufficient facilities, freedom and authority to get on with the work expeditiously without any hampering red-tape. This can be ensured by allotting to him the budget set apart for this project. Junior scientific workers should be encouraged to participate fully in putting forward the ideas on which the research programmes are based and executed.

It is desirable to set out at regular intervals (of not longer than one year) a list of existing projects and possible additional ones in an order of priority. The research programme is then drawn up working down such a list as far as the resources will allow. It is obvious that extra careful consideration needs to be given to those projects which come close to the line. Also it is to be expected that some existing projects will as a result of such a review fail to make the grade and be dropped.

5.7.2. The problem of priority becomes even more important in asessing projects that are expected to go on to the pilot plant scale. Involving as it does larger financial resources by way of costly equipment and concentration of men and materials, the pilot plant stage should be taken up after getting a clear idea of its possible economic and engineering feasibility. Once a decision is reached, the team should complete the work in the quickest possible time and no relaxation should be permitted at this stage If the pilot plant could be undertaken in partnership and at the premises of an industry, it should minimise the time lag to application.

Most of the laboratories have rightly set up a good number of pilot plants and some of these have been imported. We feel that except for very special purposes, pilot plants should not be imported. They should be designed and built within the country on the basis of laboratory findings. If after a reasonable period of trials on pilot plant scale, a process does not prove to be technically or economically feasible, there should be no hesitation to write-off the pilot plant. Components as may be useful can be utilised in putting up other pilot plants.

5.7.3. The existence of industry and discipline oriented research laboratories in the same organisation should stimulate inter-laboratory projects with two or more institutes collaborating on the different aspects. Such an arrangement would ensure concentration of specialist talent from different fields leading to the projects being handled at a higher research level and with quicker results. Problems could also be exchanged between industry and discipline laboratories. In the inter-institutional endeavour universities could also be drawn in as important partners. Research workers should also be able to move with their programme to institutes with better facilities or higher degree of specialisation. The Headquarters, may also pass on some projects of national importance to more than one institute jointly and help by coordinating their efforts.

5.7.4. Most directors find it very difficult to decide when to drop a project which is not coming up to its earlier promise. The difficulties here are mostly psychological and therefore must be handled with a combination of tact and firmness. Cognisance of the importance of projects on the waiting list generally helps in the decision whether to continue an existing project.

5.8. Growth of Size of Institutes

In the years to come, the institutes are bound to be faced with the problems of growth beyond the size convenient for unitary functioning. Large multi-discipline laboratories are good for the scientific health of the institutes as they provide better opportunities for inter-mixing of scientists of different disciplines, forming inter-disciplinary teams and cross fertilisation of ideas.

However, the larger the institution, the more difficult are the problems of direction. Larger institutes should have autonomously functioning units or give rise to units growing into sister laboratories which could be in the same campus. A similar purpose could be achieved by a number of loaboratries or their field stations being in the same campus and sharing common services.

5.9. Location of Research Institutes

Location of a research institute can be a factor in its success or an impediment to its progress. Its ability to attract and retain good research staff will to an extent depend on its research atmosphere, the social and community services and other facilities. An academic institution or university in the neighbourhood can be a help in building a healthy research atmosphere based on exchange of ideas and mutual participation in intellectual endeavour. Lack of repair and servicing for machinery, equipment and instruments can hold up progress of research work and developmental projects. Physical remoteness from the user industry can delay the application of successful applied research. At the same time, location in cities that have grown in size and population to an extent that non-availability of space for future expansion and living accommodation for the staff particularly in the lower grades, would create social problems.

The following considerations should play an important part in determining the location of research institutes:

1. The commodity or industry-oriented laboratories should be located close to the principal centres of users.

2. Regional laboratories and discipline-oriented laboratories should be located near to a university.

3. Location of new laboratories in crowded cities where the population density has already created civic and social problems should be avoided. In such a case, it may be an advantage to locate them in a nearby suburb or medium size town. Similarly, location in out of the way places having no civic or social amenities or workshop, engineering and academic facilities should be avoided.

4. Where more than one research station or institute belonging to the CSIR is located in the same town or when the central laboratories are setting up their field stations, it would be of advantage to locate them in the same campus.

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CHAPTER 6

LABORATORIES OF THE COUNCIL — CENTRAL INSTITUTES

6.1 Distribution versus Centralisation

The functions assigned to the CSIR, as set down in Chapter 2, relate to the whole of the sub-continent, a nation of 16 states, an area of 3,260,000 sq. kilometres and a population rapidly approaching 500 million. This presents a formidable task which can only be approached by balancing the various factors. The highly specialised nature of science and technology and the shortage of scientists requires the latter to be concentrated in strong central laboratories, each of which then has the problem of keeping in touch with the areas remote from its location. As the whole nation needs to become science minded it is important that these central laboratories be distributed as far as possible throughout the country, bearing in mind the need in each case for an industry-serving unit to be near a concentration of its industry. On the other hand, communications between CSIR laboratories are of the greatest importance because of the common nature of many problems and wide distribution makes these very difficult.

A closer insight into the problem of distribution versus centralisation can be gained by looking again at the three main stages in research and development:

(a) The first is the identification of the technical problem, and the preliminary exploration leading to a precise description and a possible method of attack thereof.

(b) The placing of a project on the programme of a research laboratory and the concentration thereon of effort by specialists until the most promising solution is carried through the pilot plant stage.

(c) The 'Selling' of the solution to the people who should use it.

Obviously the first and especially the last favour distribution while the second favours centralisation.

6.2. Types of Laboratories and Institutes

The laboratories and institutes of the Council are listed in Appendix II. They could broadly be classified as follows:

1. Those based on a distinct scientific discipline such as the National Chemical Laboratory, the National Physical Laboratory or the Central Electro-Chemical Research Institute.

2. Those concerned with a specific commodity or a sector of industry such as the Central Fuel Research Institute and the Central Drug Research Institute.

3. Those connected with a branch of public utilities such as the Central Building Research Institute and the Central Road Research Institute.

4. Regional Research Laboratories.

5. Cooperative Research Associations.

6. Museums and similar institutions.

To them must be added various bureaux and service organisations such as the Indian National Scientific Documentation Centre, the National Register, etc. Finally there is the headquarters of the Council and the secretariat.

Despite the Committee's wishes, it has not been possible in the time available to visit and review the work of all the laboratoriors. The Committee have, therefore, made a broad survey confining their review to (i) the role and utility of these institutes, (ii) their common problems, (iii) and special problems pertaining to some of them. Much thinking and effort has gone to a study of how these institutes could be made more useful to their specialised field of industry or public utility and what orientation or changes would draw them closer to their 'users'. The Committee's recommendations mainly have this as their aim.

In the following paragraphs, we offer specific comments and recommendations in respect of some of the institutes, either due to the urgency of their problems or to the special position they occupy in the economy and scientific effort of the country. This is followed in subsequent chapters by a review of the principles governing establishment of Regional Research Laboratories and field stations and of Cooperative Research Associations of Industry in the context of 'user' participation. The importance of central coordinating and services sections and the secretariat is also considered.

6.3. National Chemical Laboratory, Poona

The National Chemical Laboratory is a vigorous and active research institution. It is well-equipped and well-staffed. In fact, there is no better-equipped laboratory for chemical research in India. Nevertheless, we have heard many criticisms of it, particularly from industry. These are largely to the effect that NCL is too 'academic' and had been, of in sufficient help to the chemical industries. We are of the opinion that there is substance in their criticism although we feel that the fault for the lack of cooperation lies partly with the industries concerned.

It is of the highest importance that the vigour and efficiency of the NCL should be properly harnessed to the aspirations and needs of the nation. The policy and practice of the laboratory should therefore be reviewed in the light of the general recommendations made in this report and in particular we recommend that special attention should be paid to three matters :

i) The balance between 'basic' and 'applied' work, at present about 50 : 50 should be altered until the applied work reaches about 80 per cent of the total effort of the Laboratory. The basic work which remains should be either of the background type related to the applied work of the programme, or be concerned with the development of expertise in general chemical techniques, which could be of wide value.

ii) The bulk of the 'applied' work of the laboratory should progressively be concentrated in a number of important fields of chemistry and should not be allowed to become too diffuse. The first task before the Laboratory and its Director and Executive Council, with the assistance of industry is to select these fields from the present range of activities of the Laboratory. We are of the opinion that the following are specially suitable for inclusion:

(a) *Intermediates*—It would be of great value if NCL became the research unit of an Indian organic chemical industry and could act as limited source of supply of a number of key organic intermediates, fine chemicals and of tested information covering their method of manufacture up to and including the pilot plant scale.

(b) *High Polymers*—We would at this stage favour the further development of high polymers research within CSIR as a division of NCL rather than by setting up a separate institute.

(c) *Fermentation Chemicals.*

(d) *Inorganic Chemicals* specially those containing Rare Elements from indigenous sources.

(e) *Dyestuffs* and textile auxiliaries.

(f) *Catalysts* and catalytic reactions.

(g) To these primary objective divisions could be added service division dealing with pilot plant and chemical engineering, general techniques etc.

Once this task has been completed and the divisions of applied work have been selected, the next stage is to select the programme in each field. The task of problem identification is of particular importance and we recommend that expert panels including both the research staff of the Laboratory and scientists and others from industry be set up to select the programme of each division. There would have to be a separate group for each main field of work, the panel would report to the Executive Council through the Director. We further recommend that the programme of these applied divisions be pursued as far as possible in the form of projects, so that the work would have definite objectives to which time scales could be attached. The team of workers in each project would be drawn as appropriate from the various expert groups in the Laboratory. It is of particular importance that there should be a clear and fruitful liaison between NCL and other research establishments of CSIR with a clear division of field of common interest.

iii) We have been struck by the very large number of (about 70) Ph.D. students working at NCL and the very large number of CSIR

> fellowships held there. This is a reflection of the high standard of the staff and the excellence of the equipment. Nevertheless, we feel that the movement has gone too far and that there is a considerable danger to the institution from a diversion of the interests of the senior laboratory staff which must accompany the supervision of the students.

We are of the opinion that where rare or unique facilities are involved tudents should continue to have access to NCL and also that it would be unrealistic for the situation to be reversed until universities can provide similar opportunities. We, therefore, do not recommend any drastic action but rather a steady two point programme, first that equivalent facilities for chemical research should be built up in a few selected universities and secondly that the number of Ph.D. students should be progressively reduced to a limit of about one-tenth of the permanent scientific staff of the Laboratory. It may be necessary to make some minor compensatory increase in the number of the junior staff of the Laboratory.

If these changes were brought about, we feel that NCL would play even a more active role in India's industrial development.

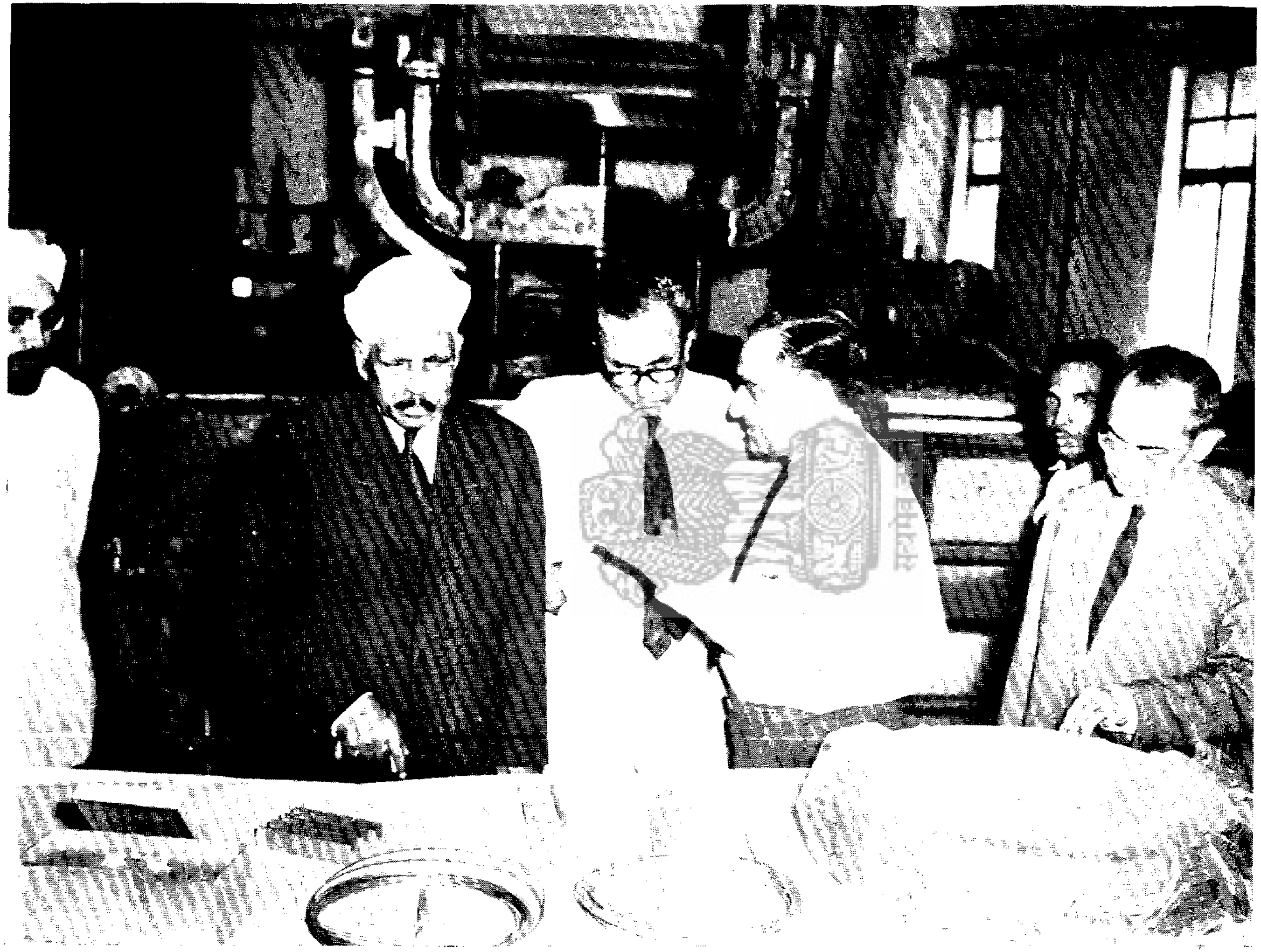
6.4. National Physical Laboratory, New Delhi

The National Physical Laboratory presents special difficulties and special opportunities. It has a distinguished record of achievement and a high level of staff. Much excellent work is going on. Nevertheless, it suffers today from uncertainties in policy which have affected the general morale.

We propose first to make some positive suggestions about the future policy and programme of the Laboratory. We feel confident that these should form a main part of the activities of the Laboratory and should enable it to play a full and active part in the scientific work of the country. We follow these proposals with some comments on the 'fundamental' work of the laboratory and on its general organisation.

Proposals—We agree with the policy recently advocated by Prof. P.M.S. Blackett, F.R.S. and accepted by the Executive Council of the Laboratory, in that greater emphasis should be given to the applied work of the Laboratory. In this we include its essential and central concern with standards and testing. The applied work should develop around these, the present principal divisions of the Laboratory. Apart from standards and testing we would recommend that support and encouragement be given to the vigorous Radio Components and Ceramic Pilot Plant Unit and the Radio Propagation Unit. The sections on Electronics, Acoustics, Optics and Industrial Physics should be developed, also the Time Unit. We would recommend a revival of the Applied Mechanics Division, with its work re-oriented to give support to the activities mentioned above.

The work of the NPL links closely with that of other parts of CSIR and it is particularly important that liaison should be active. For example the NPL could provide most valuable support for the scientific instruments industry, in collaboration with the newly established Central Scientific Instruments Organisation of CSIR.



Reviewing Committee at the National Metallurgical Laboratory, Jamshedpur (November 7, 1963)

Right to Left : **Dr. S. R. Sen Gupta**, Member, **Dr. B. R. Nijhawan**, Director, **Shri K. T. Chandy**, Member, **Sir Ramaswami Mudaliar**, Chairman and **Shri Baldev Singh**, Secretary.

We feel that publicity is badly lacking about the useful activities of NPL and its achievements and services by way of testing and standardisation facilities. Steps to remedy this should be taken.

As regards the 'basic' work of the Laboratory we would emphasise again what we have said in other parts of this report, namely that the bulk of the 'basic' work of a CSIR laboratory should be related to and form the background of its applied work. This is particularly true of NPL and there are wide and exciting possibilities in this direction. However, at present largely for historical reasons, there are groups in NPL which are concerned with 'pure basic work' with little or no connection with applied work. We feel that the emphasis should be changed over a period of time towards applied work as suggested above.

We do not think it would be appropriate for us to deal with this matter in detail but we think it proper to set out two general principles:

1. Research laboratories should not be formally divided into separate wings, 'Pure' and 'Applied'. This tends to isolation and intellectual snobbery. Matters are made worse if the two wings become administratively separate with separate directors.

2. If 'Centres of Advanced Studies' are to be set up in any scientific discipline such as Physics, these should be set up in universities and not as parts of CSIR establishments. CSIR can be of the greatest assistance to the formation of these units both financially and in other ways, but the universities are the natural and appropriate homes for 'Advanced Studies'.

A solution to the residual problems of the NPL should be sought by application of these principles.

6.5. National Metallurgical Laboratory, Jamshedpur

This Laboratory with its dynamic approach to applied work has forged close links and won the confidence of the metallurgical industry. Its favourable location in the proximity of some of the important units of industry partly accounts for its success. The Laboratory has extensive pilot plants and has carried plant tests of indigenous raw materials, given design data, undertaken beneficiation of ores and minerals and has been the main research laboratory for the iron and steel industry in the public and private sectors. However, the activities of the Laboratory in respect of non-ferrous metallurgy need greater attention and considerable expansion.

Whereas valuable work has been done in the testing, upgrading and pilot plant work on materials, the work of design for industrial plants would have to be expanded much more if the Laboratory has to fulfil the role of consultant to the metallurgical industry.

This important laboratory is already of a size that presents some of the problems referred to in para 5.8.

NML is doing extensive work for industry for both the public and private sectors, supplying essential data, project reports etc. The charges made for these are much lower than would be made by foreign consultants. We feel that for the project reports prepared by the Laboratory, suitable methods of costing should be introduced and even if these reports are to be supplied to industry at a reduced cost this should be on some accepted basis.

Due to the Laboratory's pre-occupation with developmental research, the 'objective basic' research in the field has not received adequate attention. We suggest that greater attention should be paid to the long range programmes of research.

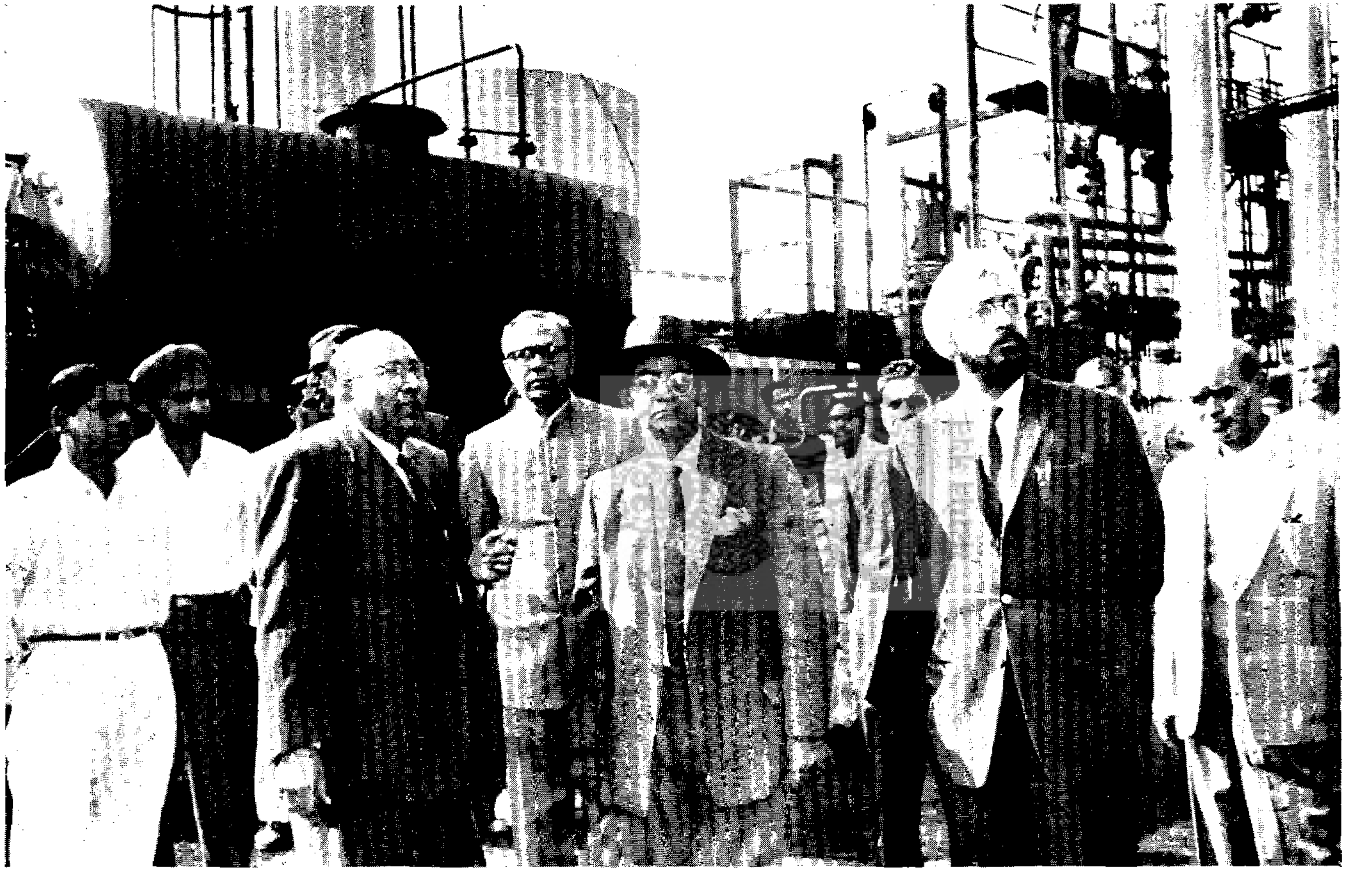
6.6. Central Fuel Research Institute, Jealgora

The Central Fuel Research Institute is an impressive institution with extensive large scale pilot plants dealing with the beneficiation of coal and processing of coal by low temperature carbonisation and its conversion into various chemicals and byproducts. We were greatly impressed by the contribution made by the Institute to the industry by the supply of design data which has enabled the setting up of large scale coal washeries. A significant contribution has been made in upgrading and blending of coal for the steel industry. The Institute has also contributed greatly to planning of the rational utilisation of coal for different uses. We welcome the links established by the Institute with the Ministries concerned with consumer aspects such as Ministry of Steel, Mines and Heavy Engineering, Ministry of Railways, the Coal Board and and the National Coal Development Corporation. These should be maintained and strengthened.

The large volume of applied work and the pre-occupation with the problems of industry has prevented the growth of 'basic objective' research required to sustain good applied work. We consider that time has come to encourage an improved balance in this respect.

With a great degree of foresight and in the absence of a more suitable agency, the Institute has also built up a chain of survey and testing stations which draw samples from the various public and private owned collieries. However, the organisation has become too large and a certain degree of reorganisation is called for. The work of the Institute is over-burdened by routine analysis and testing. While we fully recognise and appreciate the necessity of information regarding coal compositions to be made available to the Institute to plan its research programmes, we recommend that the Survey stations should be organizationally separated from the Institute. These stations should continue to work in close collaboration with the Fuel Research Institute, the Geological Survey of India and the authorities responsible for the mining of coal in the public and private sector, whose major interests they in any case serve. Indeed the CSIR should investigate the possibility of letting the survey stations be run jointly with or by the user department, while ensuring that the links with Central Fuel Research Institute remain.

A proposal has been made for the separation of the fundamental work and the pilot plant projects into two separate locations, the former being transferred to Ranchi. As in the case of NPL we are opposed to any such separation and we strongly feel that basic research in such institutes should be of an objective character linked with the long range aspects



Reviewing Committee at the pilot plant block of the Central Fuel Research Institute, Jealgora (December 19, 1963)

Right to Left : **Dr. N. Das Gupta**, Scientist, **Shri Baldev Singh**, Secretary, **Dr. S. R. Sen Gupta**, Member, **Shri K. T. Chandy**, Member, **and Dr. A. Lahiri**, Director.

Reviewing Committee at the optical glass plant of the Central Glass & Ceramic Research Institute, Calcutta (February 5, 1964)

Right to Left : **Shri Baldev Singh**, Secretary, **Dr. Atma Ram**, Director, **Sir Charles Goodeve**, Member and **Shri K. D. Sharma**, Deputy Director.

of applied work itself which would best be provided by being in the same institute under the same director.

6.7. Central Glass & Ceramic Research Institute, Calcutta

This Institute has made an important contribution to industry and defence in the development of a production unit for optical glass. We are also impressed by the fact that the programmes of the Institute are closely linked with and greatly appreciated by the industry of which the the Institute enjoys confidence. The research problems of the Institute are clearly defined and are not too many in number and the balance between applied and basic work is well maintained.

We were glad to learn that the production unit for optical glass functions as a separate unit. We feel this unit would further benefit by being insulated from the day to day operation of the Institute and adopting the methods applied to a regular production unit. This principle should be of application not only in this Institute but also in others where sizeable units are in regular production, making marketable products.

The Executive Council of the Institute is headed by an industrialist and we suggest that the Council should consider associating panels of scientists and industrial technologists with the various fields in which the Institute operates. Four panels dealing with glass, potteries and ceramics, vitreous enamel and refractories respectively should be set up to assist in the formulation of the programme of work.

In Chapter 8 a suggestion for financial association with one or more industries in respect of the institutes like C.G. & C.R.I. has been made. It is possible that the industry is not yet ripe for setting up a Cooperative Research Association of their own but a formula midway between a Cooperative Research Association and a completely independent laboratory could be worked out wherein the industry can become a co-sharer in the finances, direction and formulation of programmes and control of the Institute.

6.8. Central Food Technological Research Institute, Mysore

This is one of the biggest laboratories under the Council and at the time of our visit the new Director had taken charge only recently. He informed us that he was reorganising the programme of the Institute on a project basis with a greater bias towards applied research and utilisation of the results of research. Since the Director is himself a scientist who has worked in industry, we hope this will help in drawing the Institute closer to the food industry.

The Institute has many problems of common interest to the Ministry Food & Agriculture and the Ministry of Health. At one time the Ministries of Food and Agriculture and Health were agreeable to financing a part of the research and the nutrition wing was actually set up with financial assistance from Indian Council of Medical Research. Such participation by the user ministries and organisations should be welcome not so much from the financial point of view but more from the angle that it ensures their interest in the work of the Institute and its speedy utilisation.

6.9. Indian Institute for Biochemistry & Experimental Medicine, Calcutta

While some of the work of the Institute is of a biochemical nature dealing with anti-cancer agents and vegetable drugs, the major part is concerned with problems dealing with human diseases. An outstanding success has been the work on cholera.

Normally one would expect an institute of this type to be sponsored by the Ministry of Health who would greatly benefit by its research. However, this Institute was a struggling private medical research institute which was taken over by the Council in 1956 when the Indian Council of Medical Research was not in a position to help.

There appears to be a controversy on the location of the Institute. From some points of view, it would be good for its future healthy growth to shift it in due course to the proposed site at Kalyani from its new building at Jadavpur which is in a congested area. We have discussed earlier the principles on which location should be based and Kalyani would appear to satisfy some of these.

6.10. Central Electro-Chemical Research Institute, Karaikudi

The Committee was not able to visit this Institute, but had discussions with the Director and others. The Institute is still facing serious difficulties in its working due to its unfortunate location. For every small requirement they have to draw on Madras and their separation from industry has adversely affected the utilisation of their work. The lack of social amenities have stood in the way of their being able to retain younger scientists of proven merit. Recently they have opened a 'Centre' at Madras where they may demonstrate their processes to representatives from industry who would be reluctant to visit the Institute itself. Since the progress and utilisation of their work are likely to be indefinitely hampered, the Institute should at an early date be moved to Madras.

6.11. Central Leather Research Institute, Madras

This valuable Institute has close links with the leather tanning industry in both towns and villages. In addition to improvements in the techniques of treatment of hides and skins, preservation and tanning, the work of the Institute has an important social aspect, village tanning being mostly in the hands of the backward classes of society. The extension services of the Institute are doing an excellent job. The Director has experimented vigorously with some novel techniques of drawing the industry close to research with obvious success. He has also shown initiative in orienting research to serve export promotion since the commodity is a major foreign exchange earner. Forward thinking regarding the future of leather industry and its research requirements finds a place in its future programmes. The institute is a fortunate in having cordial relations with its neighbouring university departments. We would recommend a survey and assessment of the total requirements of the leather-based industries, in respect of equipment, machinery, chemicals etc., and expansion of the research activities of the institute to meet these where necessary in collaboration with other research laboratories.

Reviewing Committee at Central Food Technological Research Institute, Mysore (February 6, 1964)

Right to Left : **Capt. Srinivasan**, Scientist, **Dr. H. A. B. Parpia**, Director, **and Sir Patrick Linstead**, Member

6.12. Central Drug Research Institute, Lucknow

India has a rich tradition in the use of vegetable drugs and herbs for amelioration of human disease through the Sidha, Ayurvedic and Unani systems of medicine. Chemical and pharamacological research on Indian medicinal plants is being carried out at a number of Indian universities and CSIR laboratories. However, major investigations have been carried out in countries abroad and foreign pharmaceutical concerns have introduced active principles from some of Indian drugs into the pharmaceutical field.

We recommend that the Central Drug Research Institute, Lucknow should develop into a major centre for a thorough and critical research into the chemical, pharmacological and clinical aspects of Indian vegetable drugs. It should, in addition coordinate the work on Indian vegetable drugs in progress in other institutions in India.

In addition, there are several avenues of fruitful collaboration with the Indian Council of Medical Research, Ministry of Health and their Institutes. The Institute should make full use of these.

6.13. Central Building Research Institute, Roorkee

This Institute was established in 1953 and has 7 Divisions covering areas of structural engineering, soil mechanics and other aspects of building research. Several interesting and practical problems are being actively pursued especially in the sections on builing materials, efficiency of buildings, building practices and productivity and soil mechanics. The work of the section on design and performance of structures would gain if closer collaboration is achieved with other departments of government concerned with building activity. It may also be useful for the Institute to publish selected monographs and technical reports of value to the building industry. The work could also gain if the connections between the Institute and the Earthquake Research Centre at Roorkee University were made more active.

6.14. Central Road Research Institute, New Delhi

This Institute has been quite successful in selling itself to the users. Its consultancy service has been impressive. The CRRI has undertaken several useful research programmes to evolve procedures for the rational design of pavements. Its soil suction studies could be extended in scope to some advantage. Also the work on test-tracks bears extension to the rigid type of pavement. The work of this Institute would gain if cooperation with user departments in the Ministry of Transport and the CPWD is further extended.

6.15. Central Mechanical Engineering Research Institute, Durgapur

Planned in 1958 this Institute is still in its formative stages. Construction of some of the buildings is complete and a fair amount of equipment in metrology has been acquired. The Committee suggests that the Institute should proceed to select a few well chosen areas of benefit to the industry and gradually extend its activity. Mechanical design should be given special attention.

6.16 Central Mining Research Station, Dhanbad

Established in 1955, the Station deals with problems connected with coal and metalliferous mines. The CMRS has already proved its usefulness by undertaking projects of considerable value to the work in mines. The Station is reasonably well-equipped and would stand to gain if its senior staff is strengthened.

6.17. National Aeronautical Laboratory, Bangalore

This Laboratory started functioning in temporary premises in 1960. The first main project has been the planning, design and construction of the Wind Tunnel Centre with the assistance of UN. Special Fund. The major task of this laboratory is first to complete the construction and putting into operation of a 4′ × 4′ trisonic wind tunnel as an immediate and urgent aid to the aircraft industry. Work on this project is well underway. The Laboratory will be well advised to initially concentrate on forging intimate links with the nearby aircraft industry and gradually extend its activities.

6.18. Central Electronics Engineering Research Institute, Pilani

The Institute enjoys a high reputation. Pilani, where the Institute is located is a little out of the way place. However, it is within approachable distance from New Delhi and collaboration with the National Physical Laboratory is made easier. Recently some industrial units have come up in Faridabad and Delhi and the Institute has forged close links with these.

Setting up of field-stations by the Institute is recommended (see para 7.6.2.).

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Reviewing Committee at the Wind Tunnel Block of the National Aeronautical Laboratory, Bangalore (November 21, 1963)
Right to Left : **Shri Baldev Singh**, Secretary, **Late Dr. P.** Nilakantan, Director, Sir A. Ramaswami Mudaliar, Chairman, and **Dr. S. R. Sen Gupta**, Member.

CHAPTER 7

REGIONAL RESEARCH LABORATORIES AND FIELD STATIONS

7.1. Regional Research Laboratories

At present the Council has regional laboratories at Hyderabad, Jammu and Jorhat, the first one being the largest and most active. A fourth regional research laboratory is being built in Orissa at Bhubaneshwar and others are being considered for establishment.

7.2. Functions, Set-up and Future Development

The functions and future of the Regional Research laboratories can be viewed in the light of principles stated in paras 5.8. and 6.1.

In a vast country like India where long distances separate the specialised laboratories or institutes from their users there is a good case for setting up of some laboratories or stations which may provide good opportunities for links with local industries so that they do not think of research as something remote. Against this is the risk of undue duplication of facilities of the central institutes. The availability of scientific personnel and need for coordination of the programmes of the central institutes, the regional research laboratories and the field stations must also receive due consideration.

7.2.1. The regional research laboratories should have one or two fields preferably related to the raw materials and resources of the region in which they should develop a higher degree of specialisation. In this connection we would like to commend the example of the Regional Research Laboratory, Hyderabad which specialises in the low temperature carbonisation studies on low grade coals and in the field of vegetable oils and fats. The regional research laboratories should also be encouraged to carry out work on testing and standardisation of a type that would ensure improvement in the quality of products of local associated industries. They should also be in a position to forge close links with the neighbouring universities and could sponsor some research schemes in the science departments of these universities. The regional research laboratories could also assist the specialised laboratories and function as their local contact for the processes awaiting utilisation.

7.2.2. To summarise we recommend that careful analysis of various aspects including finances and personnel should precede the setting up of regional laboratories.

The main function of such laboratories should be:

i. The identification and preliminary exploration of problems arising in the region and, where appropriate, the passing of these to a specialist laboratory.

ii. Undertaking continuous educational activity with industries in the region to show them the advantage of applying science. (Publications in the local language should be undertaken).

iii. More specifically to ensure that projects of potential local application are brought to the attention of local industries and that they are assisted in overcoming obstacles.

iv. To assist the associated local industries in testing of their products and quality control.

v. To act as hosts for field stations belonging to specialist laboratories.

vi. Itself to eventually become a specialist laboratory, either for a branch of science or for a field of local interest, under coordination by the CSIR with the work of others.

7.3. Regional Research Laboratory, Hyderabad

This is the oldest and the most active of the three existing Regional Research Laboratories and has served as a model for others. In one or two fileds, the Laboratory has attained a degree of specialisation, while maintaining its multipurpose character. In low temperature carbonisation studies of the low quality coals of the region and in its work on vegetable non-essential oils and fats, the Laboratory is ahead of any other institute in the country. The research programmes excepting possibly that of the Biochemistry Division are industrially oriented with a certain degree of emphasis on the regional requirements. The set-up of the Laboratory should provide a pattern for future regional stations which should specialise in one or two fields but bear a multipurpose character.

We were happy to learn that the Low Temperature Carbonisation Pilot Plant processing 20 tons of coal a day is making profit and has in the nine years of its operation already paid for its capital investment. The Committee is not aware of the reasons why large scale LTC plants based on the data available with the Laboratory had not been set up. In spite of the existence of low grade coal in the area, and the high cost of fuel which should be favourable factors, the process has not been utilised industrially. It would be interesting to make a case study to identify the factors responsible for this.

The good work done on paints does not appear to be widely known to the industry and better publicity of the right type to the concerned industrial organisations is called for.

7.4. Regional Research Laboratory, Jammu

The field of specialisation of the Laboratory is medicinal plants in which the region abounds and on which the Laboratory has built a strong tradition. Chemical technology and engineering divisions have been added and work on raw materials and minerals occurring in the State recently started. The Laboratory is yet in the process of growth and development but its field of specialisation and lines of work have been correctly chosen.

7.5. Regional Research Laboratory, Jorhat

The development of this laboratory is quite unsatisfactory, a fact largely attributable to its location in an area far removed from any academic organisation or industry. The CSIR would be well-advised to move it to Gauhati thus giving the Institute a reasonable chance to develop and contribute to the progress of the region.

7.6. Field Stations of the Central Institutes

A Central Institute's task of identification of technical problems, of their preliminary exploration and finally of the application of completed processes can be facilitated by its having a certain number of field stations in various parts of the country. This policy is already followed by the research institutes for Food, Leather, Mining, Public Health, Metallurgy, Fuel, Engineering and some others. The facilities for these extension centres should essentially be such as to enable them to contact the local industry and assist them in translating into practice the results of research carried out by the parent specialised laboratories. Efforts should be made to invite the local indusry to share in the financial participation and control of the field stations. In appropriate cases, it may even be desirable to let the industry or the 'user' have the entire control and responsibility for a field station wherever possible. In this connection we have elsewhere advocated the transfer of Coal Survey Stations to their main 'user'.

In respect of these field stations there are additional conflicting principles. As each station would have to be relatively small, its overheads for technical and administrative services would be high unless it was attached to a laboratory already existing in the region. On the other hand, such an attachment could lead to ambiguities in regard to the lines of responsibilities and to problems of priorities regarding use of the services. These ambiguities and problems have usually been found to be solvable. Each field station must be under the control of its parent central laboratory for its technical work and finances, but must fit in with the operations of its host laboratory.

7.6.1. Basing on the above considerations, the two large industrial areas Calcutta and Bombay respectively could each benefit by having a group of field stations on one site. The building at Jadavpur when vacated by the Indian Institute for Biochemistry and Experimental Medicine may satisfy this need for Calcutta.

7.6.2. Since the electronics industry is mostly concentrated near Bangalore and Bombay, the Central Electronics Engineering Research Institute could well locate field stations at these places with user participation.

7.6.3. The Central Food Technological Research Institute, Mysore, has a number of field stations. Financial participation and joint control with local industry should be highly desirable in this case also.

CHAPTER 8

USER PARTICIPATION—RESEARCH ASSOCIATIONS

8.1. Importance of User Participation

The importance of getting the potential users of research projects to take on a share of the responsibility for Government-supported research has been emphasised repeatedly in this Report. Indeed, in many countries it is accepted that industrially-oriented research should remain primarily the responsibility of the industrial user. Absence of participation or co-operation by the potential users may not affect the quality of the reasearch from the point of view of scientific advance, but such absence does leave a difficult gap to be bridged when it comes to application.

Participation by the potential user is important for the following reasons:

a) it ensures that the needs and economic problems of a particular field are properly considered at the time the research programme is formulated.
b) It provides a mechanism of guidance for the research. This mechanism becomes progressively necessary as the project approaches the pilot stage.
c) It helps the user to anticipate relevant technical progress in considering his future plans.
d) It speeds up the application of the results of research.

It is obviously essential in any form of participation that the financial costs and risks be shared between the user and the Government.

8.2. Industrial Co-operation

The mechanisms which can be used to obtain joint responsibility for research where the users are industrial companies, public or private, are numerous and vary from continuing partnership schemes, as in the research associations, to *ad hoc* development contracts made to individual companies. Both of these have been well established abroad and to some extent in India. There are possibilities of intermediate types of organisations and also, of course, other mechanisms, such as reciprocal representation on directing bodies.

8.3. Research Associations

The term 'Research Association' is generally applied to an organisation set up by the companies in a specific industry in partnership with the government to carry out co-operative research and related technical services for these member companies. This type of partnership, started in the U.K. nearly fifty years ago, has been generally very successful and has now spread to most industrialised countries. In twelve European countries there are 250 such co-operative organisations*. The pattern varies somewhat, but the essential point is that an independent organisation is set up, which attracts members from its specified industry, and from related industries. The share of the cost paid by government varies enormously, but averages about a quarter of the total. There are in addition many co-operative research organisations throughout the world in which the government plays either a very minor or no part. Methods of winning financial support from the industry also vary widely, but some form of levy, voluntary or compulsory, is common.

8.3.1. Advantages of Research Associations

In addition to the advantages of user participation referred to in para 8.1, the mechanism of a research association provides an effective method of decentralising responsibility and of gaining flexibility to meet local circumstances. The other main advantages are:

i. The economic use of manpower and equipment in that the benefits of one organisation are shared by many companies.
ii. The availability of a centralised body of specialised knowledge and facilities.
iii. The provision of a ready channel of flow of information from widespread sources, such as universities, government and industrial laboratories, and from countries abroad, and its interpretation to interested parts of industry.
iv. The provision of a mechanism which can gain an intimate knowledge of the problems of a particular industry.
v. Training of people for industry.
vi. The increase of co-operation between an industry and the makers of its plant and equipment.
vii. The enhancement of technical competition to the ultimate benefit of the 'man in the street'.

The main difficulties that have been found in operating a research association are concerned with the formulation of the research programme; a wide range of membership interests introduces pressures to spread the programme too thinly. These difficulties have been overcome when an R.A. has a strong executive staff.

Industries which are not science based often cannot appreciate the value of research until they have seen some of the results. In the early stages, therefore, it may not be possible to gain a very wide membership in any one industry. As the work progresses, however, it is likely to be found that the companies that hang back will be won over.

*Report on structure of Industrial Research Associations (O.E.C.D.) to be published shortly.

In addition to these difficulties of getting co-operation between companies, which are common in all countries, there are added difficulties in India (and in Canada). Most industries are geographically spread over the large area of the country and often have local or State loyalties that would need to be submerged if they were to join in an R.A. in another part of the country. In India foreign owned companies have not been so keen to join research associations because this might mean pooling their imported specialised knowledge. However, while some pooling is desirable, experience in other countries has shown that this is not a necessity. The CSIR could help by inducing the reluctant members of each industry to be more cooperative.

8.3.2. It has been found in practice that three conditions must be fulfilled before co-operative research can start and flourish :

1. The research unit must be associated with a definable industry and preferably one that already has a trade association.
2. In that industry there must be a substantial number of managers who take a wide national view of the functions and responsibilities of their industry and who would be prepared to work on its Executive Council.
3. These managers and the staff of the unit must be backed by a strong nucleating and stabilising force, such as that provided by the CSIR

These three conditions make possible the recruitment of a strong staff and enable this staff to take a wide view and avoid over-attention to narrow interests or to problems which companies should deal by themselves.

8.4. Research Associations in India

In India the textile R. As. are working well. They all have close links with their industry and are geographically distributed with advantage. Furthermore they have a good mechanism for integrating their programmes and exchanging information. In the cases of the newer textile R. As., the balance between testing work and *ad hoc* investigations as compared with research is too high on the side of the first, but we expect that this will improve with time. An offer to bear a larger share of expenditure on technological research by CSIR and a corresponding reduction in expenditure on testing, quality control and trouble shooting may be an inducement to orient the programmes in the right direction.

Five research associations for the cement, paint, rubber, plywood, and wool industries respectively have been formally set up, but none of these has really made a start with their research work. They seem unable by themselves to get over their initial difficulties.

While welcoming the positive policy adopted by the CSIR in respect of research associations, the Reviewing Committee considers that there is room for further action in this direction. The present policy leaves the initiative regarding the setting up of a new co-operative research unit

Reviewing Committee at the SASMIRA Museum, Bombay (February 3, 1964)

Left to Right: **Shri S. Rajendra Rao, Shri D. N. Shroff,** President, SASMIRA, **Sir Charles Goodeve,** Member, **Sir Patrick Linstead,** Member, **and Shri J. G. Parikh,** Deputy Director, SASMIRA.

largely to the enthusiasts in a particular industry. There are many hurdles to be overcome in the first stages and help should also be obtainable outside the industry. For example, the CSIR could do more in selling the idea of co-operative research to a group of companies in an industry by adivising on the organisation and exerting gentle pressure towards a decision regarding geographical location. It could also offer temporary accommodation in one or other of its research laboratories. Specially favourable financial conditions should be offered for the first five years and indeed this could be offset by lowering the percentage of the total recurring grant by successive stages, finally setting at a level of between one-third and one-half.

While the research associaion is a proved form of co-operative orgaisation, it might be desirable in some cases to start with some intermediate form as described below. The research association form should then remain the target for the future.

8.5. Development Contracts

(i) *Contracts from Government to Industry*—In the USA, the UK and many other countries one of the most powerful tools to promote technical progress has been that of the development contract. The use of such contracts originally arose mainly from defence departments and later from atomic energy and other govenment organisations, such as railways. They were intended to be followed by purchases and indeed the promise of such a commercial advantage was often an important stimulating factor.

In the UK (through the D.S.I.R. and N.R.D.C.) and in the USA the development contract has been extended to civil purposes without any association with potential government purchases. The object in these cases has been purely to stimulate technical progress. Contracts usually take the form of an agreement to produce the first working model of a new piece of equipment. The recipient of the contract sometimes makes a financial contribution himself. The terms vary, but in general the recipient holds a proprietory right to the exploitation of the results, subject to certain safeguards retained by the government agent.

In such cases it is important that the government nominates one of its laboratories or a research association to be associated with the contract to monitor the conditions, to supply background research facilities and to follow up side lines. Such contracts help to improve the links between the research laboratory and industry.

It is recommended that the CSIR makes trial development contracts with companies willing to follow through some of the work initiated in one or other of the laboratories. In some cases the contract should cover part of the risk of the first stage of commercial production.

(ii) *Contracts from Industry to Research Institutes*—Almost all the CSIR laboratories undertake work for particular companies on a contract basis. These are valuable from every point of view and should be encouraged.

8.6. Intermediate Forms of Co-operative Research

Joint responsibility between industry and government has been found to be so essential and so successful that mechanisms other than research associations or development contracts should be explored. The following are put forward more as illustrations than positive suggestions, but each should be examined further.

(i) There are a number of cases where there already exists a CSIR laboratory doing excellent work in the field of a specific industry, but where that industry takes little or no share in the responsibility for the work. The whole could be converted to a research association, but there might be serious difficulties to be overcome and an intermediate form of organisation might be preferable.

For example, the Central Glass & Ceramic Research Institute has four main divisions serving glass, refractories, pottery and vitreous enamel respectively. It also has supporting service and sections for fundamental work in silicate chemistry and solid state physics. An improved organisation might be to form four "Industrial Research and Development Councils" relating respectively to the above four industries. These councils would consist primarily of people from industry, but would also include a certain number of scientists in universities or in other research institutes. Each council would raise money from its industry preferably by a voluntary levy scheme and be granted an equivalent amount by the CSIR. It would use this money mainly to finance the work of the relevant division at the Central Research Institute, but could use part of its funds for supporting work at universities and for development contracts in particular companies. It would in this way take a primary responsibility for the research programme, except for some of the fundamental work which would be financed by the CSIR. The end result might be that approximately one-third of the finances for the whole Institute would come from industry. This type of organisation would differ from a research association in that all of the staff would be employed by the CSIR and 'seconded' to the work of the research council. There are various possible arrangements here, but the main point would be that the scientists so seconded would be responsible to the research council for their programme of work and progress. In personnel matters they would deal with the CSIR officials.

The Central Leather Research Institute could form a similar example, but the factories are so small and the present set-up works so well that a change is not very important.

(ii) In the case where an industry is so far not covered by central research facilities, such as the paper industry, it would form a Research and Development Council which would promote research work in one or more laboratories either National, Regional or in a University. It would similarly draw half of its finances from the CSIR and would not be charged for overheads when it made a contract with one of the laboratories. The contrcts would be on a project basis, but with a certain amount of continuity implied. Such a research council would thus use CSIR staff, but would have a small staff of its own for purposes of co-ordination. Its headquarters could be associated either with a trade association or with another research organisation. In the course the industry would have its own research institute to service its needs. The research in indigenous raw materials and design of machinery could form an important part of its research programmes.

(iii) A third type of co-operative organisation would be applicable to the case where a strong CSIR laboratory existed but where there would be difficulties in forming a research council either because of geographical problems or because of a problem of definition of the industry. This can be illustrated by reference to the electronics industry which is widely distributed. The CSIR already has a Central Research Institute covering this field of activity, but this Institute lacks sufficient contact with its various industries.

It should be possible for local companies in an area such as Bangalore or Calcutta to form a 'Local Development Council' whose main object would be to bring knowledge from the Central Research Institute to the local industry and to advise companies on their own problems. Each L.D.C. would be provided with finance on a similar fifty-fifty basis with the CSIR and would draw its staff on secondment from an existing laboratory. This staff would include people skilled in operational research as well as in electronics and they would thus be able to advise member firms over a wide range of problems. They would also provide a feed-back of problems requiring research to the Central Institute at Pilani. They would be housed in a regional research institute or local university.

Already several of the central research institutes of the CSIR are finding it necessary to have fieldstations in different parts of the country. An excellent opportunity lies here for making a first step in user participation.

All three of these forms of collaboration would require further consideration and elaboration, but it is believed that it would be well worthwhile experimenting with them in other ways. An attractive feature is that user participation can be progressively developed until the optimum point in each case is reached.

8.7. Industrial Participation at Headquarters

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The re-orientation of the work of the CSIR towards participation by industry in much of the work of the research laboratories ranks as one of the most immediate and major tasks facing the organisation. It is important, therefore, that the staff at headquarters should be strengthened to supervise and press forward such a change. It is to be noted that even stronger steps in this direction are being taken in the U.K. (See para 9.12 and 9.13).

8.8. Industry in the Public Sector

A substantial part of the work of the CSIR laboratories is related to industry which contains companies in the public sector. This is particularly true of the National Metallurgical Laboratory, the National Chemical Laboratory, the Central Fuel Research Institute, the Central Mining Research Station, the Indian Institute of Petroleum and the National Aeronautical Laboratory.

In theory the problem of ensuring user-participation should be simpler here in that the director of a laboratory or one of his senior people can become a part-time director on the board of the public company. More advantage should be taken of this possibility and where such an arrangement is made the functions and responsibilities of the part-time director should be clearly specified.

At the same time public sector companies should be encouraged to take up financial participation in given research laboratories either by means of *ad hoc* contracts or by membership of research councils or research associations.

8.9. User Government Departments

The CSIR is already heavily committed in work where the user is to a major or a minor extent a department of government. Examples here are the three Central Research Institutes for building, roads and public health engineering respectively. Here the arguments for the research work being controlled by the CSIR, on the one hand and those for its being controlled by the user department are difficult to balance. No generalised answer can be given other than to say that if one government department represents the majority of the users and is willing and able to maintain the conditions necessary for creative work then there is an argument for its having the prime responsibility for its research work. At the same time the Reviewing Committee recommends that the CSIR continues to open up new fields or to strengthen fields where the current research work is weak even if these concern the interests of other government departments.

The conditions to be fulfilled before a user government department could take over the prime responsibility for any of the fields mentioned above, are unlikely to be met in India for some years yet, mainly because these departments are too occupied with day-to-day problems. Nevertheless, it is essential that the participation by these departments in the guidance of work of these Central Research Institutes be increased. It is not sufficient to have members on the Executive Council representing the user department. The latter should form a special group of its own staff charged with the responsibility of the application of research results and should be given finances not only for this purpose, but also to enable it to share the cost of operating the research institute. Without financial sharing, responsibility has no substance.

The research institute should operate somewhat like joint subsidiaries commonly to be found in industry to serve two or more independent companies. The CSIR would be the 'major shareholders' but the agreement with the user department would be carefully drawn up as it is in industrial practice to ensure that decisions are made which incorporate the user's point of view.

In the case where the major participant in a research organisation is a user government department, a crosslinkage with the CSIR should be built in and this can be both financial and through the staff system. The personnel for such an organisation could be drawn from the scientific civil service and appear on the books of the CSIR. They would, however, be seconded full-time and for an indefinite period to the research organisations for their work, but retain a personel link with the CSIR.

The functions of the CSIR in this latter case are:

(a) To ensure that a progressive technical policy is adopted
(b) To help create an atmosphere for creative work
(c) To assist in recruiting and other staff problems
(d) To assist in co-ordination throughout the many research institutes.

As in the case of the new proposals for industrial participation, there are many details to be worked out. Some of these could be anticipated, but others can only be arrived at by trial. It is recommended that bold steps to invite user participation at different levels be initiated and that these possibilities be explored further.

For similar reasons as in the case of Central Institutes of the CSIR (para 6.2) only some of the co-operative research associations are discussed below:

8.10. Laboratories of the Ahmedabad Textile Industry's Research Association, Ahmedabad (ATIRA)

The laboratories at Ahmedabad are the largest amongst the three Co-operative Research Associations of the textile industry, the other two being located at Bombay and Coimbatore. The ATIRA also has field centres at Indore and Ujjain. The reasons for there being three separate laboratories are mostly the convenience of location in nearness to the mills that they serve. Considering the fact that a large amount of testing work on behalf of the factories is being undertaken, this is readily explained. ATIRA laboratories have also an active and growing group of Operational Research workers who have carried out a number of time and motion, quality control and process improvement studies in the factories.

CSIR bears 50 per cent of the recurring and capital expenditure of ATIRA which is one of its most successful examples of co-operation with industry. CSIR helps without exercising any administrative controls. The industry has a feeling of 'ownership' of the institute and the contacts are healthy, intimate and fruitful in respect of utilisation of the results. The institute is located in the neighbourhood of the Gujarat University and the staff and senior students of the University are permitted use of the specialised equipment and facilities. Since textiles are a major item in India's exports, the quality requirements of the recipient countries find a place in the research programmes of the ATIRA.

With all this, and although the institute discourages too much of routine testing on behalf of the factories, the predominant work of the institute is over-weighed with testing. In other countries, government support is more for research of an applied nature of long range benefit to industry rather than for testing, quality control or industrial psychology which would be entirely financed by the industry. Whereas there might be some justification for this latter work in the beginning, a certain degree of adjustment whereby CSIR support is increasingly used for applied research would be desirable.

One of the difficulties of the textile industry is the long time taken by overseas suppliers of machinery. Sometimes they take more than 3 years and as a result the machinery may be obsolete by the time it is imported and installed. There appears to be no research institute on design of textile machinery and the starting of a unit in ATIRA would be of great benefit. It may not be out of place to suggest that location of a Regional Research Laboratory, if contemplated for Gujarat in the ATIRA campus may have several advantages by way of common services, inter-mixing of research staff and growth of a community-sense among the scientists.

8.11. Indian Paint Research Association

It would be advantageous for the association to have a laboratory of its own located at Calcutta—another centre could be located at Bombay; these two cities having the largest concentration of paint manufacturing companies. When these centres come into existence, the CSIR laboratories can handle the long term applied research or basic objective research pertaining to the industry, leaving the short term problems for solution by these units. Till such time, the association should take greater advantage of the well-equipped and staffed laboratories of the CSIR. It will be advisable to attach an expert panel of scientists from the paint industry to the concerned division of the CSIR laboratories to advise on the formulation and execution of the programmes. CSIR could also help the association by persuading the reluctant members to be more co-operative.

8.12. Indian Rubber Research Association

The problems faced by the rubber industries research association are similar to those of the paint association. One of the firms, a subsidiary of a foreign company, has recently set up a research laboratory of its own. We would recommend action on the lines indicated in 8.11 above.

CHAPTER 9

THE HEADQUARTERS AND TECHNICAL SERVICES

9.1. Functions of the Headquarters

The Second Reviewing Committee had recommended that "The Central Executive should leave as much detailed administration as possible in the hands of the various institutes, acting in a coordinating and guiding capacity. The Council should maintain close relations with other departments of State (Education, Health, Works, Agriculture, Food, etc.) and other scientific and technical organisations (e.g., scientific societies) so that the scientific organisation can be an organic whole." (p. 64). To these coordinating and liaison functions of the headquarters, we should like to add two others:

i) the responsibility of ensuring that the researches under CSIR fit into the overall pattern of the country's planning and

ii) formulation of policies for research with a view to better utilisation.

In the context of the above-defined functions we should like to compliment the CSIR on the recent setting up of a number of technical servicing units at the Headquarters. Their work in collecting scientific, technical, economic and statistical data will play an increasingly useful role in the planning of scientific research and formulation of science policy in keeping with the requirements of the country's development.

9.2. Administrative Services

9.2.1. We welcome the some recent implementation of the recommendations of the Second Reviewing Committee in the form of decentralisation of administration and enhancement of the powers exercisable by the heads of the Stations. This is a step in the right direction. Since most of these steps are only recent, it is too early to judge their impact but we have no doubt that the decentralisation of administrative functions needs to be carried further and faster. The laboratories should be able to function almost autonomously within the general framework of policies of the Council and within the financial limits set, without day to day control from the headquarters.

9.2.2. We would like to commend an even bolder policy for the Headquarters by divesting itself of responsibility for all routine administration and retaining such functions as are consistent with its role in coordinating, liaison, policy formulation and implementation. This and the associated policy of strengthening of the technical services sections would necessitate the redeployment of the present supporting administrative staff at the headquarters. In this context it is also necessary that the administrative procedures and grades should be reviewed. Full use should be made of the administrative autonomy of the CSIR in pushing ahead with these decisions.

As an example, decentralisation of authority for small foreign exchange is of importance (see 4.2). We learn that the Director-General now has an allotment at his disposal. Some proportion of this could be re-allocated to directors with powers to use it for purchases involving small amount of foreign exchange.

9.2.3. However, administrative decentralisation should not mean rendering the Headquarters and the Director General ineffective in their function of policy making and implementation, or as corrective to something that may go wrong in any of the units of the CSIR. It is necessary to provide overall powers to the Centre for effective intervention where need be.

TECHNICAL SERVICE UNITS AT HEADQUARTERS

9.3. Survey & Planning of Scientific Research Unit

This unit was established in 1963 and has done some pioneering work in the collection and analysis of data on expenditure on scientific research.

Despite the difficulty in obtaining reliable figures and in their interpretation such data are important for any intelligent planning of scientific research. The unit should be strengthened and its work coordinated with the corresponding units in the Planning Commission, Central Statistical Organisation and other bodies in possession of or engaged in similar studies. The combined data, which would embrace the entire field of scientific research in India would be a help to bodies concerned with planning, policy making and development of research.

9.4. Research Coordination, Industrial Liaison and Extension Services Unit

This Unit maintains suitably documented information on research in progress at the various laboratories. This assists internal coordination between the CSIR laboratories and external coordination with other organisations such as the Railways, the Indian Council of Agriculture Research and the Indian Council of Medical Research and others. It also maintains contact with the Directorate General of Technical Development, Ministry of Industry and other government organisations responsible for planning and industrial development and thus indirectly it supplements the efforts of the Liaison Units of the laboratories. It also functions as the channel for contact with the National Research Development Corporation for research utilisation. The Unit issues a quarterly 'Information Newsletter' containing a brief account of researches accomplished by the various laboratories which are of use to industry.

The activities of this Unit have a key function in determining the picture of research in the country and planning its future development.

As the instrument of contact with industries and user government departments, its functions will have to be strengthened and organised.

9.5. Defence Coordination Unit

Since the Defence Research and Development Organisation has some 30 research laboratories, many of them working in similar fields as some of the institutes under the CSIR, liaison machinery for constant exchange of information and coordination with them is essential. The National Emergency of 1962 gave a special urgency to this task and resulted in the CSIR setting up a separate unit for picking out and identifying the problems concerned with Defence, farming these out to its laboratories, following up the progress and conveying back the results to the Defence Organisation. Some 87 projects undertaken on behalf of the Defence have been successfully tackled by the CSIR laboratories.

An additional activity of the Unit should be to identify such results of research from the Defence laboratories which are capable of civilian exploitation and promoting their utilisation by industry.

9.6. Central Design & Engineering Unit

The First and Second Reviewing Committees had stressed the need of carrying out the researches in the National Laboratories up to a pilot plant scale so that the industrial utilisation of the research results could be assured and technical and economic data made available for upscaling to industrial operations. Even this step, however, has not been enough to enable the industry to use the results of research carried out in the laboratories. The main reason for this is the absence of any well-developed engineering consultative services in India.

In order to fill this gap and thus ensure the utilisation of the results of research, the Council set up a Central Design and Engineering Unit in 1963. This Unit is expected to undertake detailed engineering design, economic studies and project evaluation as also the procurement, erection and commissioning of industrial plants on processes developed by the National Laboratories. In para 13.4, an extension of the activities of this Unit is recommended.

9.7. National Register Unit

The Council set up a National Register Unit in 1948 which maintains a roster in card index form on the availability, qualifications and experience of scientists, engineers and medical personnel in the country. The Unit has a section for Indians abroad which keeps information on qualified Indians in foreign countries.

Manpower research based on the data available on topics including the qualification levels, age distribution, pay group analysis, inter-state mobility, occupation pattern, sectors of employment, unemployment analysis, subject-wise distribution of Indian scientists and engineers in various foreign countries, their expectations of pay, their duration of stay abroad, trend of their return to India etc. is carried out. In a limited way, assistance to well qualified unemployed personnel is rendered in securing employment. The Unit registered 84,000 persons during the period January to September 1963 and the total number enrolled so far in the General Register stands at 250,096. It publishes a bulletin called 'Technical Manpower' which gives availability, qalifications and experience of scientific and technical personnel in India and abroad.

We would recommend the strengthening of its research aspects by the unit continuously reviewing the requirements of scientists and technologists in various fields and the steps being taken by the teaching organisations to meet their needs. These studies could be undertaken in collaboration with the Institute of Applied Manpower Research or other organisations concerned with collection of statistical data about technical manpower. The Unit could also maintain documented information about the expertise available in different fields of science and technology and serve as a scientists' 'who is who' in India (also see para 11.1.)

9.8. Patents Unit

This is at present a service unit for receiving patent applications from the laboratories, carrying out a limited screening and processing these applications with the Controller of Patents in India and where foreign registration is necessary with the patent authorities abroad. In a country which is moving towards rapid industrialisation, information about the patents is of importance in keeping abreast of the progress of research, particularly applied research. The Unit should subscribe to the patent journals and other patent technical literature from the industrially advanced countries of the world. The activities of this Unit should be expanded so that it may provide such other assistance and information about patents that the laboratories may require from time to time.

9.9. The Publications and Information Directorate

The Directorate was set up in 1942. Details of the technical publications brought out by the Directorate are given in para 2.10. The format of these is very impressive and compares favourably with those in the countries abroad but the circulation should be considerably improved. The policy regarding contributions to these journals does not limit them to research papers from the laboratories of the Council but contributions are invited and received from the universities and other research organisations also.

There is a feeling that this policy may have an adverse effect on the publications that are being brought out by the learned societies. The publication of journals by learned societies in all countries is a normal feature of their activities. The Council should encourage similar development in India by giving financial and other support to enable them to work up to good standards.

9.10. Indian National Scientific Documentation Centre (INSDOC)

We have studied the reports of the activities of INSDOC which mostly consist of supplying to individual scientists and organisations translations of foreign language articles and research papers, microfilms and photo-copies of articles and preparation of bibliographies on selected topics. The Centre is also bringing out the following 3 journals:

1. INSDOC List of Current Scientific Literature
2. Annals of Library Science
3. Bibliography of Scientific Publications of South and South-East Asia.

We recommend that the servicing activities of the Centre in respect of the supply of reprints, microfilms and translations bibliographies etc. should be enlarged and made much cheaper. Speed is the essence of utility in service of this type.

The publications activity of INSDOC should be reconsidered in the light of demands of the national laboratories and other users in India. In this, the availability of efficient documentation and abstracting services by agencies abroad should be taken into account.

9.11. Publicity

We would like to emphasise the fact that due to lack of proper publicity the good work done by CSIR and its laboratories is not sufficiently known either to the public or even to the user organisations. In Chapter 4 we have referred to the critical comments by people holding important positions in social life and industry who were not aware of the valuable contributions made by the CSIR institutes to the industrial and economic development of the country. Expansion of this activity, however, would defeat its own purpose unless the objectives were precisely defined and the targets and means of communication carefully selected.

The broad objective here is clear; the application of knowledge for the benefit of the people. This may be detailed to particular objectives, such as

(a) to spread knowledge of those developments which are ready or nearly ready for application. Examples are those which are approaching the end of the pilot plant stage and those in use

(b) to indicate that successful application can bring returns and that difficulties in making changes can be overcome

(c) to give public recognition to individuals and companies who have been progressive in promotion and utilisation of research.

The potentialities of the part that publicity can play in promoting utilisation of results of research have by no means been exhausted and we would recommend that the publicity aspects should be closely looked into and properly organised.

9.12. Industrial Participation and Central Technical Services Units

In the preceding paras we have dealt with the activities of the technical service units at the Headquarters.

The wide scope of the technical service units described above and the need for industrial participation to which we refer in a later chapter, call for coordination and leadership at a high level. We therefore recommend that immediate consideration be given to the strengthening of the scientific staff at the Headquarters.

9.13. We visualise a great expansion and substantial reorientation of the work to be done by the Headquarters' Sections necessitated by the projected expansion of the activities of the CSIR as a whole and the key role it has to play in assisting the government in formulating and implementing a National Policy of Science. References to this have been made in the preceding paragraphs as also in subsequent chapters. The achievement of this task requires not only the strengthening of the scientific and administrative staff at the operational levels but also the appointment of one or more high level deputies, as may be required by the development of work, who could help the Director General in performing his all important role of scrutiny and coordination, particularly of the technical operations.

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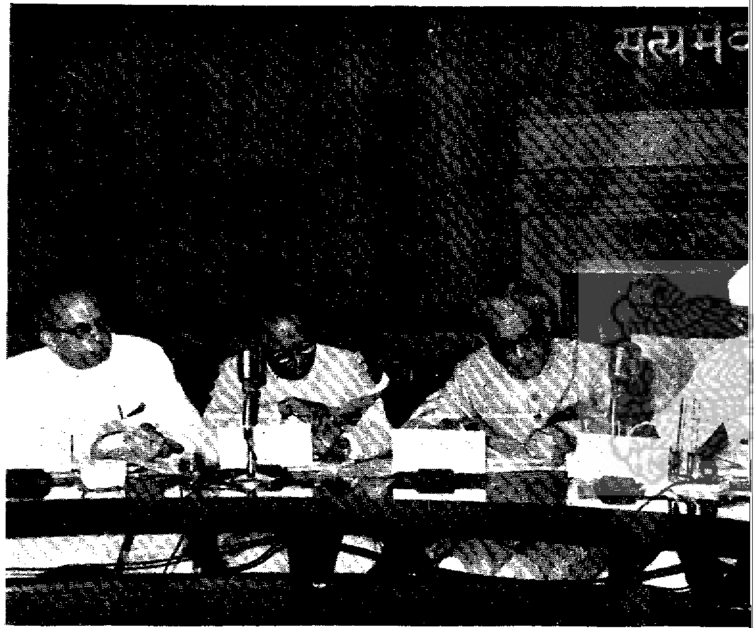

A view of the meeting of the Governing Bod

Right to Left : Shri **A. K. Mustafy,** Secretary, **Dr. S. Husain Zaheer,** Directo
President, **Shri M. C. Chagla,** Minister for Education & Vi
& Chemical, and **Shri Nitya Nand Kanungo,** Minister for Indu

CHAPTER 10

GOVERNING BODY, EXECUTIVE COUNCILS AND SCIENTIFIC COMMITTEES

10.1. Governing Body

In this chapter we turn to the controlling machinery for the policies of the CSIR and its relation with the executive bodies of the laboratories and institutes.

It is of very great value to have the Prime Minister as the President of the Governing Body and the concerned Minister as Vice-President and such other Ministers as the President may choose to nominate as members. The rest of the Governing Body should consist of representatives from the universities and the industry and other segments of national life engaged or interested in research and development. Links with other government departments and ministries must be maintained continuously through regular channels.

As the supreme body of the Council, the Governing Body mainly deals with matters of over-riding policy and the relations of the CSIR with other government bodies and research organisations, and with the plans of the country as a whole. This requires a compact body, the strength of which could be reduced from its present number, without deviating from the principle of representation on it of the important organisations.

At the time when the Governing Body is reconstituted, it would be of advantage to give consideration to introducing of some new members.

10.2. Board of Scientific & Industrial Research

The Governing Body should continue to be assisted and advised by the Board of Scientific & Industrial Research whose main function would be to deal specially with the scientific work and activities of the Council and its laboratories. It would also function as the coordinating body for its 'Specialist Committees' (see para 10.3) who would be its main organs for the consideration, evaluation and review of policies in various fields.

Its membership is mostly drawn from scientists in the universities, industry and a few directors from the CSIR laboratories. The strength of its membership may appropriately be limited to 20-25 for effective functioning. Here also at the time of reconstitution the principle of bringing in new people may be considered.

10.3. Specialist Committees

We recommend the setting up of 'Specialist Committees' by the Board whose function would be of an advisory nature in regard to those aspects which would require more detailed consideration than the board will have time to give. At present there appears to be no systematic method built into the organisation for continuous consideration and review of policy in these matters. For example, we would suggest the setting up of the following Specialist Committees and others if necessary:

1. Research relations with the universities
2. Industrial research and relations with industry
3. Scientific and technical manpower

These Committees should be constituted jointly of persons from the CSIR and scientists from the universities and industry who should be chosen for their special knowledge in the appropriate field. Their membership should include some members of the Board and should be limited to 10-12 in number. Each Specialist Committee should have a senior member of the Headquarters' staff to take executive action on their behalf. They should meet periodically and review the position in their fields and make suitable recommendations to the Board. Data collected by the Technical Services Units at the Headquarters should be constantly made available to them to enable them to make recommendations based on scientific facts and figures.

10.4. Councils, Scientific Committees & Panels of Experts

We now turn to the 'Councils', at present called Executive Councils which have the responsibility for the "control and general direction of the laboratories within the framework of rules and regulations and directives issued from time to time by the Governing Body." They should mostly consist of people from the universities and industry. We support the steps which we understand have been taken to limit their membership to 12 and we suggest that consideration to introducing fresh members should be given at the time of their reconstitution.

We welcome the steps recently taken to enhance the powers of these Councils as to make their functioning more or less autonomous. The Councils should have the complete responsibility of putting forward a programme of work and allocation of funds for different projects and services within the budget provided for the individual laboratory.

The Councils should be assisted in the matter of research programmes by their Scientific Committees mostly consisting of scientists from academic institutions and from industries with the director of the laboratory as chairman. We have also advocated the setting up of 'panels of experts' to help the director in drawing up of the programmes of the various research divisions. The Scientific Committees should coordinate the working of the panels and set out their recommendations in the form of a programme for the laboratory.

Part III

CHAPTER 11

STAFF

11.1 Scientific Personnel

The most important factor in the success of a laboratory is the quality of its director and of the research staff. The rapid development of India has meant that the demand for able and qualified scientific personnel has greatly exceeded the supply coming from the institutes of higher learning in science and technology. It would be a valuable exercise for the National Register Unit of the CSIR to estimate and forecast the demand of different categories of specialised staff in various disciplines that would be required by the laboratories of the CSIR and other organisations during the Fourth and Fifth Five-Year Plans. This could be compared with the provision and turn over of this type of scientific staff by the teaching and research institutions. In the absence of any exact data, it would be reasonable to assume that there will be more jobs than there are men to fill them. In such a situation a dilution of talent becomes a real danger and the research institutions must take special care not to staff their organisations with a surplus of mediocrity. After having recruited competent staff they should take special care to offer them such incentives, atmosphere for work, conditions of service and freedom to choose their work within the overall programme and priorities as would make them an asset to the institutions. The staff should be so allotted and their responsibilities so fixed in regard to their work as to ensure the most productive use of their effort.

11.2. Recruitment Procedures and Service Conditions

At present recruitment to all scientific posts is through advertisement and selection through committees. Recruitment upto the posts of Scientist Grade 'B' (Rs. 400-950) has been made the charge of the laboratories concerned while recruitment of the posts of Scientist Grade 'C' (Rs. 700-1250) and above is handled by the Headquarters. The posts of the Directors are not advertised but are filled in by selection from a panel of prospective candidates who in the opinion of the Director General and the members of the selection committee would fulfil the conditions. In keeping with our previously expressed views, we recommend that the administrative routine for posts upto that of Scientist Grade 'E' (Rs. 1300-1600) should be handled by the laboratories in accordance with standards laid down by headquarters, the actual appointments being made by the competent authority.

The time lag between advertisement and the appointment should be further minimised. We were told that a considerable number of the stanctioned scientific posts have remained unfilled. In part, this is explained by the ban imposed on fresh recruitment due to National Emergency.

It may also be due to the non-availability of suitable candidates and it must be accepted as of over-riding importance that if a suitable candidate for a research post is not forthcoming, the post must not be filled. However, if the existence of vacancies is due to the time lag or delaying administrative procedures, then the situation must be remedied immediately. We learn that the CSIR has the matter under review and has already enforced some measures for rapid recruitment, supernumerary postings, departmental promotion of meritorious candidates by screening through properly constituted committees. In addition we would like to draw attention to the following points:

i) *Movement of Staff*: The movement of research staff within the institutes under the Council and between the CSIR and the industry and universities is very slight. A system should be devised where-by in cases where this would benefit the development of his work, a research worker can move on to a sister laboratory or a university carrying with him his research problem and return back after a year or so, without detriment to his economic and other interests. This would encourage exchange of ideas, experience and information between research workers and organisations. We suggest that suitable rules to facilitate this should be introduced.

ii) *Applications for posts outside CSIR*: There appears to be no reason to restrict the right of a scientist to apply for any post anywhere in India, but we suggest that rules in this regard should provide for adequate notice for release to the authority he is serving and should safeguard the interests of the project in which the scientist may be engaged.

iii) *Promotions* : A scientist must be judged on the basis of his achievement and the reputation he enjoys amongst his compeers. For scientific and research staff the system of achievement or performance cards giving datails of his attainment in his field of work should be introduced. These could form the basis of consideration for promotion to higher posts or super numerary positions.

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11.3. Selection of Directors

The importance of the post of director of an institute makes the problem of choosing the right man an especially difficult one. On the whole the present procedure is satisfactory and has been reasonably successful in finding dynamic, capable men to fill these posts, but we consider that certain improvements in it should be made.

The first problem is for the selection committee and the Director-General to get the best possible list of potential holders. Vacancies for the posts of Senior Scientists are often, for a number of good reasons, not advertised and the list is prepared by collecting suggestions privately. This practice, however, may fail to bring a wide enough list. A vigorous attempt should be made to include names of people with experience in industry. One of the reasons for the lack of balance in the research programmes from the user's angle is because most of the senior research personnel in the laboratories have been recruited from the teaching and research staff of the universities, who may have a good background of fundamental research but have little or none of industrial research. We recommend that at the time of setting up of the selection committee a public announcement be made which would include an invitation for suggestions to be sent in writing.

As seen from Appendix II the Director's post in one-third of the institutes has been held temporarily by a deputy or assistant director. Some people have been in this position for upto three years and many of the existing directors have been through such a period. While we accept that there may sometimes be grounds for hesitancy on the part of selection committees, we believe that the disadvantage of such appointments is not fully realised. An appointment of this sort attempts to give responsibility without authority. The holder cannot enjoy confidence in handling the problems of the laboratory, because his policies and programmes may be changed by the permanent appointee. Furthermore, there are obvious psychological disadvantages if a testing period is prolonged.

A considerable part of the problem can be met by a provision for making contract appointments. In special cases where a director finds the responsibilities of his post not to his liking, it should be possible to offer him a suitable appointment more appropriate to his capabilities without substantial loss of salary.

At all events we recommend that appointments 'in charge' should only be made as a last resort and should not normally last more than one year or at the most two years.

11.4. Selection Committees

We lay the highest importance on a proper constitution of the selection committees which should be limited to a maximum of 5 persons consisting *entirely* of scientists and technologists.

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11.5. Auxiliary Technical Staff

We should like to make a special mention of the need for a close examination of the facilities for training and the salaries and grades for auxiliary technical staff in the institutes working as technicians etc. in workshops, pilot plants and instrumentation. The revision of grades of this category of staff has been done by the Pay Commission in the same manner as for the research staff. However, this has not taken into consideration the fact that the market value for the engineers and technicians has risen at a much faster rate than that of the research scientists. Whereas it may not be possible to give the technicians the same emoluments as may be available to them in the industry nor would it be advisable to put them in any position of superiority as compared to research personnel (for it would create psychological and administrative complications), it would be desirable to make some realistic assessment of the position and give them grades which are to someextent commensurate with their market value.

11.6. Administrative Staff

The administrative staff is allotted to the laboratories by the Headquarters. Excepting for appointments to junior positions, all appointments, promotions and transfers etc. are made from these. This procedure may have some advantage in providing opportunities of departmental promotion to higher cadre posts which are comparatively fewer in number. Nevertheless although technically the administrative staff are under the control of the director, in practice the present arrangement does not conform to the principle of autonomous functioning of the research institutes. It also tends to make merit a subordinate consideration to seniority in service.

We recommend that the process of decentralisation should be extended to cover the administrative cadre as well and the posts upto Section Officers should be filled by the laboratories. For senior posts the procedure may be the same as for the upper cadre scientific posts. We feel that efficiency and merit for the administrative cadre are not less important than for the scientific staff, and recommend that all posts should be filled through advertisement and selection by properly constituted selection committees.

A degree of rationalisation in respect of different categories and the grades of administrative staff is also called for and it would serve efficiency to trim the numbers in the lower categories. We consider that fresh thinking and reform in the structure and emoluments of the supporting administrative staff would be of positive assistance to the scientists in the CSIR.

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CHAPTER 12

LINKS WITH UNIVERSITIES AND TECHNOLOGICAL INSTITUTES

12.1. Role of the Universities

Research and development and in fact the entire structure of modern technological society has to be supported by a well organised system of education. In the context of the ultimate goals of progress, scientific research, technical development and education are inseparable. Research institutions and industry have to depend for their trained manpower on universities and technological teaching institutes. The nation must look to them to bring up a new generation of scientists and they have a vital role to play in the supply of trained manpower which is essential for the future of the country. For supporting the research and development in India, the universities and teaching institutions must provide a healthy and well taught under-graduate school, supplemented by a number of strong post-graduate schools in science and technology.

12.2. Universities and CSIR

The universities are also places where fundamental, basic or pure research without any restricting considerations of economic advantage or application would find the proper home. Training in the scientific method, research to satisfy the inner urge and intellectual curiosity about the natural phenomena are both the duties and the privileges of a teaching institution. The maintenance of proper standards, the quality of training and supply of sufficient numbers by the universities and teaching institutions are of special importance to the nation and to the CSIR. Support to university education and to the technical colleges would be an act of enlightened self-interest on the part of the CSIR and it must go out of its way to forge cordial relations and close links with the universities. The characteristics of the universities apart from their teaching functions are three-fold :

i) They act as a pool of manpower which can be drawn on to staff new ventures;

ii) By improving their attraction, the tendency for students to go overseas at the Ph. D. stage will be reduced and foreign exchange saved although it will be still of great advantage if selected outstanding students are sent overseas at the post-doctoral stage.

iii) They could be the "Centres for advanced research, studies and learning", where the most creative and gifted of the scientists could enjoy complete freedom to pursue research subjects of their individual choice.

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12.3. Supporting Research in Universities

The responsibility for extending financial support to the universities is shared between the University Grants Commission (U.G.C.) and the CSIR and we are commenting below on some of the measures in which the CSIR can play a vital role in extending this support.

1. The most wide-spread method is through the support of the individual student through maintenance grants and fellowships. The liberal attitude of the CSIR in this regard has already achieved excellent results and the number of fellowships and grants should be increased to keep pace with the demand for skilled men.
2. Next is the support that the CSIR can lend to 'Research Leaders' in the universities. The support can be by way of research schemes and funds for equipment for a field of research selected by the universities. Normally, this should be for pure basic work. So far as the grants to the investigators are concerned, these are quite extensive. To this may be added grants including foreign exchange for specialised equipment where provision for it may not be possible by the universities (see para 4.3.). The role of the CSIR would be particularly to support schemes in the new and rapidly developing fields. When a research effort has become established as an integral part of the regular work of a university, it would be appropriate for the financial support to be taken over by the UGC.
3. The laboratories under the CSIR should start a number of research schemes in their neighbouring universities or teaching institutions. Normally such support should be extended to a particular field selected by laboratories and should usually be for objective work, either basic or applied connected with the research programmes of the laboratory itself.
4. The CSIR could finance for limited periods institutes or departments for advanced teaching and training in subjects of direct interest to its specialised manpower requirements in selected fields, e.g., the CSIR could sponsor departments for advanced teaching in coal technology, metallurgy, chemical engineering and such other subjects where there is an acute shortage of trained scientists.
5. In consultation with the university concerned and the University Grants Commission, the CSIR could offer funds for the creation of research professorships in selected fields to supplement the resources of the teaching departments in the universities. Sufficient care in such a case should be taken that the arrangement is with the closest consultation and agreement of the institutions concerned.

The above are the main lines of support. In addition, there are a number of other ways in which the CSIR laboratories and universities can cooperate to mutual benefit:

1. The scientists from the universities could sit on the executive councils, boards, selection committees and panels as independent experts.
2. The CSIR laboratories can share the use of their specialised equipment and instruments with the senior members and the teaching and research staff of the appropriate universities. This would be a good arrangement provided it is done in a manner so as not to disturb the main regular work of the laboratory.
3. The CSIR laboratories can receive by agreement a limited number of Ph.D. students from the universities to take advantage of the expert knowledge and equipment available in the laboratories.
4. The staff of the CSIR institutes and laboratories can assist in the teaching work of local universities by giving special lectures, seminars and in many other ways. Here again this must not be allowed to develop to the stage of becoming a distraction for the research workers from their regular work nor must it be sought as replacement of the regular teaching requirements of the universities.

Elsewhere we have emphasised that we are not attracted to the idea of the CSIR laboratories/institutes or a part of them becoming 'Institutes of Advanced Studies'. The main objection to this is that the proper place for the advanced studies is inside the universities. The CSIR will be well advised to extend financial and other support to build up the institutes of advanced studies in the universities preferably in the neighbourhood of some of the discipline oriented laboratories. We recommend that the general policy of the CSIR should be to develop mutual confidence and reliance between the CSIR and its institutions and the universities.

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CHAPTER 13

BRIDGING THE GAP

13.1. Scientific Research and its Application

Every country has difficulties in ensuring that the gap between the discovery of knowledge and its application is bridged as quickly and effectively as possible. Difficulties are particularly severe in India where the shortage of people able and willing to overcome the problems of change is very acute. Further, there are many physical problems such as the absence of competition and the shortage of materials.

One of the more specific problems is that of being the 'first' in the application of a particular development. The person who undertakes this task has to solve many detailed questions which his followers do not have. It is this person who needs the greatest help and encouragement.

Most of the recommendations of this report are related to this problem bridging the gap. The recommendations regarding user participation and pilot plant and cross-links between parties concerned are all intended to narrow the gap.

There remain, however, other actions that a Government can take to overcome the difficulties and complete the bridge. These are concerned mainly with influencing the decisions of two main groups of people, those in official positions either in Central or State governments and those in industry. The three principal lines of action considered are preferential treatment, technical help and financial help.

13.2. Preferential Treatment

Every industrial company has to depend on government machinery for various types of help. The government also control the various check points and have the directive authority to favour a course that may encourage the more progressive. It can also give encouragement and preferences to those employing results of indigenous research.

CSIR is associated in a limited way with the machinery for industrial licencing which enables it to have some say and indicate preference for companies making use of new developments. We have already stressed the need for setting up of machinery for co-ordination of the work of the CSIR with the Directorate General of Technical Development, the Ministry for Industry, Planning Commission and other government departments concerned with planning and industrial development. These links could be made use of for imparting information to the government departments on the available processes, and also to work out jointly how a policy of preferential treatment to the progressive firms could be made effective.

13.3. Technical Help

For an industrial company to make use of a process involves consideration of three critical stages:

(a) The pilot plant where research results are tested on a scale sufficient to estimate the economics and practical problmes of commercial operation

(b) The project design stage, including a market study where a proposition suitable for a particular company is formulated complete with design of commercial scale equipment, and

(c) The production and operation of the first commercial plant.

There may be a subsequent stage of association in form of continuous contact and consultation in the nature of 'after sales service'.

In Indian research establishments, there are extensive facilities for carrying out pilot plant trials, but there is insufficient consultation with industry in examining these projects which are selected for pilot plant work.

It would help application if an industrial company could be associated in financial participation with the running of the pilot plant itself. A certain amount of risk is involved but the company could be partially compensated in the event of financial loss. It could be given exclusive rights for the exploitation of the process for the first few years to give it an economic advantage and make an example to others. They could also be given financial support in the setting up of a prototype plant or the first industrial unit. The government could have two main objectives: to encourage industrial research and development itself and to support the first commercial production unit.

13.4. Design and Engineering

There are in India limited but growing facilities for carrying out the second stage. Some of these are under government auspices because of the shortage of consultants and plant manufacturers who on the basis of process data, could undertake engineering design of the plants, plan their layout, installation, erection and commissioning for the clients. In the developed countries where such facilities are available, it is unusual for a research organisation to undertake the later stages of industrial design and engineering. But under conditions obtaining in India we consider this is a real gap between research and industrial utilisation of the results of research. Industry in India would like to take up only such processes which have been demonstrated practically on a commercial scale and for which complete technical and economic data along with guarantees is provided. In setting up the Design and Engineering Unit (see para 9.6) the Council has taken the right step in bridging the gap between researches carried up to pilot plant scale in the national laboratories and the stage where the industry could accept them for industrial utilisation.

The Unit will strengthen the chemical engineering and design units in the national laboratories and function in collaboration with them on specific projects which have a better chance of being industrially utilised. In addition, the Unit itself will also be undertaking industrial design and engineering for some special projects on which the data could be made available by the laboratories. The Unit could also help in the examination of the data available from laboratories to determine whether it would be adequate for industrial engineering design and upscaling. In due course the activities of the unit could be expanded to undertake design, engineering, erection and commissioning of industrial plants.

The Committee welcomes the setting up of the Unit and recommends its rapid strengthening and expansion. It also recommends that a system of costing for all work of the Unit should be introduced straightaway. The Unit could also function regularly as consulting engineers to firms and industries who may require its services. In planning their activities, the Unit should keep in view the facilities available for design and engineering elsewhere such as the engineering firms in the country undertaking design engineering of machinery for sugar, paper, textile and cement industries, the Heavy Engineering Corporation at Ranchi and the Fertilizer Corporation of India.

The Council should consider expanding the Unit as a separate institute with an independent administrative set up. This should function on semi-commercial lines in the first instance and later on fully commercial lines. It would be advisable for it to be associated with industry which could be a technical and financial co-sharer.

13.5. National Research Development Corporation

In cases where industry is not willing to carry on to the third stage the CSIR has used its powers in a few cases to go into manufacture itself or use the machinery of the National Research Development Corporation (NRDC) which has an agreement giving them the exclusive rights for the exploitation of the researches carried out by the Council.

NRDC was set up as a society in 1954 under the Registration of Socities Act (Act XXI of 1860) and acts the sole agency through which the Council can approach the industry for getting its results applied. The NRDC has the following aims and objects:

1. To develop and exploit in the public interest, for profit or otherwise, inventions, whether patentable or otherwise including technical and engineering 'know-how' of processes developed by the CSIR laboratories and other Government and semi-Government research institutes or industries.
2. To enter into reciprocal arrangements with similar organisations in other countries, to exploit Indian inventions in these countries and their inventions in India.
3. To issue exclusive and/or non-exclusive licenses on such terms and conditions regarding payment of premia, royalties share of profits and/or any other basis as are considered advisable to commercially developed inventions and ensure commercial production of the products of invention.

4. To instal and work pilot, prototype or semi-commercial units or full commercial plants to develop a particular invention or inventions and ensure production from such invention or inventions, to sell or otherwise dispose of the products of such inventions on payment or otherwise and generally on such terms and conditions as may be deemed fit.

A review of the activities of the NRDC is not strictly within our terms of reference but as these functions are vital to the success of CSIR it is essential for us to examine the adequacy or otherwise of the instrument for this work. The major activities of the NRDC during the period under review are summed up as follows:

1.	Processes licensed to industry and in production	52
2.	Processes licensed but not yet in production	63
3.	Processes for which licenses are under negotiations	14
4.	Processes for which development action has been arranged with firms	5
5.	Processes for which projects for large scale pilot plant trials were set up by NRDC	10
6.	Processes released to industry free of charge or where technical details have been published	110

The NRDC has assisted in financing 10 processes on pilot plant scale. Out of these 7 have been financed at the CSIR laboratories and 3 at other research institutes financed or sponsored by the Government. Most of the pilot plants financed by the NRDC are at the CSIR institutes and are based on their own research and could as well have been financed by the CSIR on its own. Similarly an overwhelming proportion of references made to NRDC arise out of CSIR institutes and only a few come from the universities, other government departments and the industry.

The NRDC functions through a Board of Directors nominated by the Government through the Minister for Education. The Chairman of the Board of Directors at present is the Director General, Scientific and Industrial Research and the Board consists of representatives from the industry and officials from the government departments.

The NRDC organisation is headed by an Executive Director assisted by a Secretary, a Chemical Engineer, a Liaison Officer, some technical asistants and supporting administrative staff.

Commensurate with the tasks imposed on the NRDC consequent upon its agreement with the CSIR as the sole agency to utilise the results of research, we feel that the apparatus provided to the Society and its technical capacity are a severe limitation on the utilisation of the results of research. The question arises as to whether the CSIR should continue with this agreement. Certainly, if the agreement is to be of any use, the NRDC should be brought organisationally much closer to the CSIR and its technical strength and competence should be suitably built up. For a long time to come, the CSIR and the organisations under the Government will continue to be the main clientele for the NRDC. However, it will be of some advantage to maintain a separate identity of the NRDC because it will facilitates its organisational ability to handle cases arising not only from the CSIR but also from other government departments, universities, other research institutes and industry which in any case will need to have an organisation of this type for assistance to them. We would recommend that NRDC, while remaining a separate organisation should for all practical purposes be brought under the overall charge of the CSIR and should function under the close direction of the Director General, CSIR. It should also be provided with adequate finances and technical staff for financing and building up pilot plants and prototype units for universities, government departments and industries outside CSIR who may not be able to do it on their own. In keeping with its requirements and as it makes progress, the NRDC should be considerably strengthened by co-ordination with other units particularly the Central Design and Engineering Unit and to the extent necessary by building its own technical potential.

13.6. Consultation Services

The rules under the Council provide for institutional consultancy whereby an industry can approach the national laboratories for consultation and technical help either on specific projects or on general problems of the industry. The industry can also indicate the scientist in the organisation whom they would like to consult. There is, however, no provision for individual CSIR scientists acting as part-time consultants to industry on their own. In practice not many laboratories or designated scientists are active as consultants to industry.

We feel that the consultancy not only on institutional but also individual bases should be further encouraged subject to suitable safeguards in either case.

13.7. Other Financial Help

A government has a wide range of financial powers and these are probably the most effective means of influencing decisions, particularly those of industrialists in regard to promotion and utilisation of research. In theory these powers can be used to encourage the promotion and application of research through :

i) Taxation and special allownaces etc.
ii) Straight subsidies, credit guarantees or low interest loans
iii) Financing research in private industry
iv) Development contracts

13.7.1. *Taxation and Risk Incentives*

In India there are some concessions in respect of the tax chargeable on earned incomes by industry which are utilised for research inside a company. These concessions should be further liberalised as in other countries to cover funds used by industrial companies for sponsored work in the national laboratories, universities or other organisations or research activity of any type financed and sponsored by industry. The present distinction between research carried out inside and outside the companies is not conducive to growth of research.

13.7.2. *Straight Subsidies, Credit Guarantees or Low Interest Loans*

This does not require much elaboration. Such incentives could be given to industry with suitable safeguards.

13.7.3. *Financing Research in Private Industry*

There are not many industrial companies in India which have a research laboratory attached to them. There are some examples of research organisations being set up by foreign controlled industries such as the CIBA Research Centre, the Rubber Research Centre at Truvettiyur and the Hindustan Lever. Some Indian organisations have also set up research laboratories like the Bengal Immunity Research Institute, Tata institutes and Shri Ram Institute for Industrial Research, etc. We would advocate an active policy of aiding industry to build up their research and developmen organisations and particularly the latter so that they can utilise the resultt of research carried out elsewhere. Recently the Canadian Governmens has come forward with a scheme whereby it shares the financial burden ot new research projects in industry without any strings attached. It financef for fixed periods the research in industry by supporting grants to meet thes salaries of the research personnel; equipment, apparatus, chemicals and services are provided by the industry. Roughly, this works out to 50 per cent of the expenditure on research and the results of research are wholly the property of the company concerned. The projects are carefully screened by the National Research Council of Canada. In the case of India the steps to be taken to build up research in industry will have to be even more liberal and far-reaching. We would advocate the following:

1. After proper scrutiny the CSIR should be prepared to support the setting up of research and development organisations within the individual industrial companies and give active financial support by way of a share in the capital grant and where necessary by secondment of its staff for limited periods.
2. The CSIR should also finance and support approved research projects within the company's research organisations. Here also the share of the CSIR may be 50 per cent or more where required depending on the resources of the company and the nature of the project. The company concerned should have the exclusive right to use the results of research for a definite period.
3. The number of sponsored research schemes in the CSIR at present is not very significant and this activity should be given further encouragement by a relaxation of the terms and conditions. The CSIR should encourage companies to sponsor research schemes in CSIR institutes as specific research projects by offering matching grants.

13.7.4. *Development Contracts*

This has already been discussed in para 8.5.

While all these measures will help bridging the gap, means must be found for generating a motivation in industry that should create a compelling urge for it to be progressive.

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CHAPTER 14

OPERATIONAL RESEARCH (O.R.)

14.1 Operational Research

In the years since the Second World War a new branch of applied science, 'Operational Research', has come forward to assist management in the making of decisions regarding the operations under their control. Its techniques have proved to be valuable tools for improving efficiencies and for planning both current operations and for investment. Starting with a firm economic base and by bringing in disciplines and knowledge from mathematics, engineering and the social sciences, it can show how to reduce costs or release bottlenecks to production. It is an effective and proven road to higher productivity and lower costs. Its latest successes have been in the study of human problems in factories.

Industry and government organisations in all he industrialised countries of the world have adopted operational research as a management tool alongside the long-established disciplines of accountancy. They also use the somewhat simpler techniques of work study.

14.2. O.R. in India

India has taken a leading part in one facet of the field, viz., application of O.R. to national planning. The Operational Research Society of India, working from its headquarters in the CSIR offices, is active in advancing the science on a wide front. The Regional Research Laboratory, Hyderabad, in 1949, was the first to initiate a programme of operational research studies on the problems of organisation of research and developmental work of laboratory processes. Soon afterwards, ATIRA (Ahmedabad Textile Industry's Research Association) organised a unit and started work in the textile industry. The Defence Research Organisation has also been playing a leading part in the organisation of various symposia and seminars and arranging lectures and courses and research on military problems. Indian Railways have also an active group engaged in operational research pertaining to their problems and working.

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The Institute of Management, Calcutta has an active group on operational research training and research. The Indian Statistical Institute, Calcutta, has a one-year diploma course in operational research and the Delhi University runs a post-graduate course. Some of the industries organise short courses for their representatives The Cabinet Secretariat has a course for people in the public sectors and administration, to promote the understanding of operational research. The National Productivity Council of India has a training course which includes a study of operational research methods.

14.3. O.R. in the CSIR

The impact on Indian industry and on government activities, however, falls short of what could be achieved. Much of the work is too theoretical, operational research is a practical action science. Furthermore, the term is often incorrectly applied to what are really technological studies in the factories.

A few companies and state organisations have set up teams for this type of work and these have the advantage of being close to the users. But there are far too few people in India with the necessary specialist qualifications and experience to make a fast enough impact through individual company teams. Central teams serving an industry or an area can provide a more practicable answer. Indeed this has already been accepted and acted upon to some extent but important gaps remain to be filled and the opportunities for effective work of direct economic importance are enormous.

The industry oriented research laboratories, the public utility laboratories, together with the regional research laboratories and research associations of industry provide excellent bases from which such teams can operate. Specifically strong units should be set up in the Central Road, Building and Food Research Institutes. These units would not only be valuable in the actual results obtained but also in illustrating to CSIR and to others what can be achieved by O.R. in setting standards of quality of work. Considerable use can be made of overseas experience in these developments.

Teams so placed have an important additional advantage in that they can help the directors to formulate their programmes. As these teams gain an intimate knowledge of an industry, they are also able to evaluate the importance of possible research projects.

Similarly there is a need for a strong O.R. unit at CSIR headquarters to support the laboratory teams with special techniques and with computer facilities and to carry out work in industries not otherwise covered. Conversely it can help the CSIR in its planning of research. The nucleus of such a unit already exists.

There is an equally strong need in all the institutes for O.R. to play a part in the design of every series of experiments before they are actually performed in the laboratory or pilot plants and later to help in the interpretation of results. Very often elaborate experiments done over long periods lead to incomplete results due to inadequate planning. Wastage of time and energy would be avoided if the experiments were statistically designed.

The solution of each of India's many problems depends on how quickly and correctly a decision can be made. This is likely to require a balance between a number of opposing factors and this balance can best be ascertained if their magnitude can be determined. O.R. has developed techniques of measuring many of these factors. It is recommended that the development of operational research in India be given a high priority in the Council's plans.

CHAPTER 15

FUTURE DEVELOPMENT OF CSIR ACTIVITIES

15.1. Expansion of Scientific Activity

The Committee have been provided with copies of the tentative Fourth Five Year Plan of the CSIR. If the scientific and technological activity is to match the national requirements it will have to grow manifold. This activity will have to be supported by a strong base of scientific and technical education to which we have drawn attention elsewhere. Many more scientific institutions will have to come up in diverse fields of activity in the public and private sector, in the government departments and in the industries. The CSIR would have to orient its functions so as promote this growth, supplement it where necessary and assist the government in assessing the progress of scientific activity from the overall national point of view.

We understand that the proposed expenditure on research during the Fourth Five Year Plan is to be stepped up considerably. Ideally the developing countries should spend a greater proportion of their national income on research as compared to the advanced countries. (See para 3.5.). They should also develop the methodology to utilise their research much more effectively by way of returns in terms of national economic development.

While we support expansion of the scientific activity both by way of new institutions and expansion of the existing work, we would like to emphasise the need for improvement in quality and the role of limiting factors such as the availability of suitably trained and qualified staff of good quality and merit, suitable instruments and equipment and facilities for research. These must be kept in view so as not to spread the limited resources available over too wide a field and lessen their effectiveness in performance. At the same time efficient coordinating services must be built up.

15.2. CSIR Proposals for New Institutes

We give below our comments on proposals in respect of the institutes which the CSIR might set up during the Fourth Plan period.

15.2.1. *Regional Laboratories*

The views expressed by the Committee in para 7.2.2. may be kept in view.

15.2.2. *High Altitude Laboratory*

We are not clear as to the purpose that would be served by setting up a High Altitude Laboratory and the proposal given to us is not sufficiently attractive for us to make a definite recommendation, particularly in view of the activities of the Defence Research Organisation in the field.

15.2.3. *Institute of Oceanography*

The Institute of Oceanography should be given a high priority, in view of the long coastline of India and the importance of marine products.

15.2.4. *Polymer Research*

The setting up of a separate institute of polymer research is not considered by us necessary at this stage and it should grow out of the present division of the National Chemical Laboratory by initially separating it out as a unit and building its activity by way of research programme, men and material. If progress justifies the change, it could in due course be built into a separate institute.

15.3. Special Projects

We recommend that CSIR should give vigorous support to the following projects:

i) *Population Control*

The high rate of the increase in the population in India makes its present state of poverty more acute and makes the task of economic development more difficult. Since the productivity in the agriculture and industrial fields is not commensurate with the demands of the increasing population; the additional numbers only add to the difficulties of the mass of the people.

Limiting of the numbers is as important an aspect in the goal of prosperity and healthy life in India as the application of science and technology to industrial and economic development. Institutes under the CSIR should cooperate with the Indian Council of Medical Research on means of controlling the birth rate.

ii) *Agricultural Chemicals, Pesticides and Insecticides*

Although CSIR is not directly responsible for agricultural research, it is well-equipped to support agricultural development by research into its chemical and technological aspects. Developments of newer fertilizers for different crops and soil conditions and research on plant protection and food preservation are well within its scope and competence and should receive adequate attention.

iii) *Fish Technology*

There is already a division carrying out research on fish technology at the Central Food Technological Research Institute, Mysore. Fish is perhaps the cheapest form of animal protein which can be made available to the under-nourished people in the less developed countries. Research on development of different types of edible protein foods from fish should be given a strong encouragement.

iv) There are also numerous other gaps which should be filled particularly marine engineering and packaging research.

15.4. Additional Suggestions

15.4.1. *Electrical Engineering*

We would also advocate the setting up of a National Institute for research in Electrical Engineering in which there appears to be a gap. Considering the hydro-electric generation programme and the growing electrical industries of the country, a research institute in the field would be a great asset. The planning and scope of activity of this Institute should be closely coordinated with the Ministry of Irrigation and Power and its agencies such as Central Water & Power Commission, Power Research Institute and the Heavy Electrical Engineering Projects.

15.4.2. *Research Association of Paper Industry*

Steps should be initiated by CSIR for promoting a research association of the paper industry. This would be in addition to the work already in progress at the various research institutes such as the Forest Research Institure, Dehra Dun and the National Sugar Research Institute, Kanpur.

15.5. Reviews of CSIR Activities

We conclude this Report by making a suggestion on the method of of review. The reviews of the activities of the CSIR should be related to the Five Year Plans and should be started early in the begining of the closing year of each Plan period. This would enable the Reviewing Committee to assess and evaluate the work done during the five years and project its ideas to the orientation needs or changes that could be suggested for adoption in the forthcoming Plan.

We also feel that in addition to the overall review of the CSIR, individual institutions should be reviewed by a panel of scientists once in every quinquenium. Such a review could usefully precede the review by the Reviewing Committee which would then take into cognisance the recommendations made in respect of individual research institutes.

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A. Ramaswami Mudaliar
Chairman
K. T. Chandy
Satish Dhawan
Charles F. Goodeve
Patrick Linstead
P. C. Mahalanobis
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September 21, 1964

Part IV

CHAPTER 16

SUMMARY AND PRINCIPAL RECOMMENDATIONS

SUMMARY

The Council of Scientific and Industrial Research was set up for the initiation, promotion and coordination of scientific and technological research. With its chain of laboratories in various fields, it is the largest organisation for civilian research in India. Its flexibility in function has been a great asset. While the CSIR should continue to discharge its wide responsibility in initiating and supporting research in fields where gaps exist, it should invite other government departments to take over partial or complete responsibility for fields with which they are concerned.

With the development of science and technology in the country and increasing activity in their respective fields of other organisations like Indian Council of Agricultural Research, Indian Council of Medical Research, Department of Atomic Energy, Defence Research and Development Organisation and technical departments of the ministries, a system of communication and coordination between them and the evolution of national policy and strategy for science is important. CSIR has a useful role in assisting the planning and formulation of such a policy in view of the large data and information at its disposal collected for its own activity.

While a system of communication and coordination with organisations dealing with science and technology is necessary, links with government agencies for planning and industrial development, viz. the Directorate-General of Technical Department, the Ministry of Industry and Planning Commission are of special importance. Economic reorientation of industrial research would be possible if detailed data on imports, exports and plans for industrial development, of the public and private sectors are made available to the laboratories for programming research.

The autonomy enjoyed by the CSIR which enables it to function effectively is of great advantage and should be strengthened both in regard to CSIR and its national laboratories. Recently there has been a welcome orientation in the work of the Headquarters by creation of a number of technical service sections such as Survey & Planning, Research Coordination & Industrial Liaison, National Register, Central Design & Engineering and Defence Coordination. The activities of these technical service units would require to be further enlarged and strengthened. The welcome step taken in regard to administrative decentralisation should be carried further so as to make the functioning of the laboratories more or less autonomous. The scientific advisory committees and the executive councils of various laboratories and institutes of the CSIR should be given more powers to enable them to function effectively.

There is need to orient the research programmes in the laboratories. The majority of the effort (about 80%) should go towards applied research and the remainder devoted to basic objective research related to the long range objectives of industrial research. The main responsibility for pure fundamental work should rest with the universities with which close links must be forged by the CSIR. Considering the importance to research and development of a sound supporting structure of scientific and technological education, the CSIR must take effective steps to give all support to universities in the training of technical personnel and in building up schools of research.

Steps should be taken for effective utilisation of the results of research. The setting up of the Central Design & Engineering Unit with a view to bridging the gap between the laboratory and pilot plant researches and the stage where they are scaled up to industrial size units is welcome. User participation in research should be encouraged in various forms and links with industry forged in more than one way. Experts panels comprised of scientists from industry and universities must be closely associated with programme and control of research in the research divisions in the laboratories. Industry should also be given incentives by way of financial support to start their own research and development organisations or to undertake research on approved projects with partial or full support from the CSIR.

PRINCIPAL RECOMMENDATIONS

Throughout this report many recommendations of major significance or of detail have been made. The principal ones are listed here, but reader is referred to the paras concerned (given in brackets at the end of each recommendation), for the background analysis and reasons. Several secondary recommendations in the main report have been omitted here.

1. The Flexibility in Functions of the CSIR

It is recommended that the CSIR maintains its present flexibility in function to enable it to discharge its wide responsibilities for initiating or supporting research in fields where gaps exist. At the same time it should invite other government departments to take over partial or complete responsibility for fields with which they are concerned. (5.1).

2. Relations with Other Departments

It is recommended that machinery be set up and strengthened by the CSIR for its collaboration with the Planning Commission, Ministry of Industry, the Director General of Technical Development and other agencies responsible for the collection of essential information and action in respect of the nation's economy, with the object of ensuring that national plans and problems become the basis for the programmes of its research establishments. (3.7).

3. Relations with Other Research Organisations

Machinery should also be set up for intercommunication and exchange with other research organisations and technical agencies of the Government, in particular those associated with the Agriculture, Medicine, Defence, Railways, Posts & Telegraphs, and the Atomic Energy. (3.7).

4. Expenditure on Research

If India is to make headway as a developing country its research effort in terms of quantity, quality and effectiveness will have to be increased manifold and limited only by the availability of trained personnel and resources.

It is recommended that the CSIR's part in the Fourth Plan should be implemented to the full and extended where fresh needs arise. (2.12, 3.5 and 15.4).

5. Governing Body of CSIR

The Governing Body is the supreme body of the Council responsible for its broad policy and external relations.

It is recommended that this body should be a compact one, the strength of which could be reduced from its present number without sacrificing the representation on it of the principal organisations. Consideration to introducing some fresh members should be given at the time of its reconstitution. (10.1).

6. Board of Scientific & Industrial Research

The Board should continue to assist the Governing Body and to concern itself with the programme of the CSIR and those of its institutes.

It is recommended that its strength should be limited to 20-25 and consideration should be given to introducing some fresh members at the time of its reconstitution. It is also recommended that the Board should set up a limited number of Specialist Committees to advise on those aspects which would require more detailed consideration than the Board will have time to give. (10.2 and 10.3).

7. Councils of the National Laboratories and Institutes of the CSIR

It is recommended that each of these Councils should be limited to a membership of 12-15. Each Council should be assisted by 'panels of experts' in the formulation of research programmes. It is also recommended that the present policy of decentralising administration and giving of more powers to the Councils and the Directors should be further extended, with the Headquarters maintaining an effective contact and ensuring that the policies of CSIR are carried out. (10.4 and 9.2).

8. Research Programmes

The programmes of the Laboratories of the CSIR should be mainly concerned with applied research and its related basic research. They should be framed in the context of the country's plans for industrial and economic development. The programme should be made up of well defined projects with clear objectives and the applied research projects should be time-targeted and normally not extend beyond a period of three to five years. (5.6).

9. Posts of Directors

Posts of directors should be filled as expeditiously as possible to ensure the proper functioning of the research organisations and temporary appointments should be avoided as far as possible. Where, however, the Selection Committee feels unable to make a permanent appointment of a Director with complete confidence, it could make the appointment on contract or for a probationary period. It is recommended that in either case this period should not exceed one or at the most two years before confirmation or termination. (11.3).

10. Posts of Other Scientific Personnel

It is recommended that the administrative routine for recruitment to posts upto that of Scientist Grade 'E' (Rs. 1300-1600) should be handled by the Laboratories in accordance with standards laid down by Headquarters and appointments made by competent authority according to rules therefor.

11. Location of Research Institutes

It is recommended that the following principles should operate in the siting of Institutes: Industry oriented laboratories should be located in an area containing a concentration of the industry but should avoid crowded parts of cities. An important consideration should be the availability of sufficient area for its future growth and accommodation of field stations of other laboratories and auxiliary institutes. On the other hand, out of the way places without social amenities and supporting engineering services should also be avoided. Proximity to a university should play a part in the siting of a discipline-oriented or a regional laboratory. Where more than one institute or field station is to be located in the same city they should as far as possible be in the same campus and share common services as far as possible. (5.8).

12. Regional Research Laboratories

It is recommended that a careful analysis of various aspects including finances and availability of personnel should precede the setting up of Regional Research Laboratories. Such laboratories should be multipurpose in character, but at the same time should specialise in one or two fields depending on the nature of the problems in the area of their location. (7.2).

13. Field Stations

It is recommended that the CSIR encourage its laboratories to set up a certain number of field stations preferably where these are supported by the concerned local industry and that common services are used as in recommendation 11. (7.6).

14. Research Associations

Research carried out as a partnership between industry and goverment has proved to be a highly efficient mechanism for the selection of problems and for the application of results. This mechanism permits a ready and effective means of decentralising responsibility, while at the same time permitting coordination. It is recommended that this should be extended. It is also recommended that existing research associations should look upon the inclusion of routine testing and quality control as a temporary function which should be handed over as early as possible to individual companies. (8.3).

Specific recommendations (Nos. 15-21) regarding certain individual institutes are found below:

15. National Chemical Laboratory, Poona

The balance between fundamental and applied work which at present is about 50/50 should be altered nearer to 20/80 and the fundamental work should become mainly related to the applied projects or for the development of expertise in general chemical knowledge and techniques. The Laboratory should concentrate its research effort on selected projects in fields, such as organic intermediates, high polymers, fermentation chemicals, inorganic chemicals, dye-stuffs and textile auxiliaries, catalysts and chemicals engineering and pilot plant techniques. The number of Ph.D. Students and fellowships should be progressively reduced until it is not more than one-tenth of the permanent scientific staff. (6.3).

16. National Physical Laboratory, New Delhi

The primary emphasis should be on applied work, including standards and testing. Of particular importance are the fields of radio components, radio propagation, electronics, ceramics, acoustics, optics, time measurement and applied mechanics, and in each of these fields objective basic work should form a substantial part. It is important that the Laboratory should build up an *esprit de corps* only possible in a well led single unit and it should not be divided into two wings with a separation of fundamental work from the applied. (6.4).

17. National Metallurgical Laboratory, Jamshedpur

Research in the field of non-ferrous metallurgy should be increased in collaboration with the industry. The design facilities to enable the laboratory to act as consultants help to partly fill a gap in the application of research results and these should be extended. (6.5).

18. Central Fuel Research Institute, Jealgora

It is recommended that the objective basic research at this establishment should be increased in order to sustain its important applied research, The whole of such fundamental work should continue at Jealgora and not be separated. The coal survey stations should be organisationally separated from the Institute while retaining communication links. (6.6).

19. Central Glass & Ceramic Research Institute, Calcutta

The four industries related to the four divisions of this Institute should be brought into even more active participation in the work and share in the finances. Advisory panels from industry should be set up for these four divisions. (6.7).

20. Indian Institute for Biochemistry & Experimental Medicine, Calcutta

The shifting of the Institute from its present congested location at Yadavpur may be carried out in due course. (6.9).

21. Central Electrochemical Research Institute, Karaikudi

This Institute should be transferred from its present isolated location to Madras as soon as possible. (6.11).

22. Headquarters

The role of Headquarters is broadly the formulation of policy, the coordination of research, and the provision of central technical services with the object of supporting the country's planned development.

It is recommended that the Headquarters should divest itself of responsibility for routine administration of its establishments and retain only such functions as may be consistent with the above role. (9.1 and 9.2).

23. Technical Service Units at Headquarters

In view of the importance of these services, it is recommended that they should be strengthened and expanded with special reference to the following points:

Coordination Units should be organised for contact and exchange of information with ministries and oesearch rrganisations in Agriculture, Health, Railways, Posts & Telegraphs, etc. The Defence Coordination Unit should add to its responsibilities the encouragement of civil utilisation of results arising out of defence research. The Central Design and Engineering Unit should grow into a full-scale organisation for the design, engineering, erection and commissioning of pilot plants and industrial plants in order to assist the industry to bridge the gap between research and application. It should include technical and economic evaluation among its functions. Existing scientific and learned societies should be encouraged and financially supported to enable them to raise the standard of their publications. The servicing activities of the Indian National Scientific Documentation Centre should be extended and their costs should be reduced. Publications activity of this centre should be examined in the light of abstracts and documentation services available from agencies abroad. (9.3, 9.4, 9.5, 9.6, 9.9 and 9.10).

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24. Links with Universities

Support to the Universities by the CSIR is an act of enlightened self-interest and it is recommended that the CSIR continues to increase this support as fast as possible and in collaboration with the University Grants Commission. In particular it should support schemes for 'Institutes for Advanced Studies' through providing funds for equipment, the creation of professorships, etc. The Maintenance Grants and Fellowships Scheme have already achieved excellent results, but the number of such grants should be increased to keep pace with the demand for skilled manpower. (12.3).

25. Industrial Participation in Research and Development.

The greatest weakness in the present organisation is the lack of association of industry in taking a share of the responsibility for Government-supported research and it is recommended that every possible step be taken to effect an improvement here. The research association mechanism is an excellent one for achieving this, but positive help is required to overcome the initial problems in starting such additional associations. Alternative or intermediate forms of cooperation with industry should be explored. (Chapter 8 and 9.12).

26. User Government Departments

Much of the work of some of the Institutes, such as food, building, road and public health engineering, is essential to the progress of the fields which are the responsibility of other government departments. Such departments should take a greater part in the supervision of such research and to underline this responsibility should provide part of the finances. Each such government department should have a special Unit of its own staff charged with responsibility of the application of results of research. (8.9).

27. National Research Development Corporation of India

It appears to be the general opinion that this organisation has not been able to match the country's need and should be reorganised and subtantially strengthened. Although it may remain a separate entity, it is recommended that for operational purposes, it should function under the control and direction of the Director-General of CSIR. (13.5).

28. Operational Research

It is recommended that the development of Operational Research be given a high priority in the plans of the Council and the CSIR focus its first efforts on certain establishments. (14.3).

29. Population Control

It is recommended that the CSIR should, in cooperation with the ICMR, give vigorous support to research on population control and to the communication and application of the results in the widest and most efficient manner as this problem requires urgent solution. In Chapter 15 we deal with other proposals made in the CSIR's Fourth Plan. (15.6, 3.1 and 3.11).

30. Periodic Reviews

Periodic review of the work of the CSIR in relation to the research effort of India serves a useful purpose, and it is recommended that these should take place every five years, timed to precede the beginning of each five-year plan by about one year. A review of each individual laboratory or institute should take place before the overall review. (15.7).

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APPENDIX I

LIST OF LABORATORIES/INSTITUTES VISITED BY THE REVIEWING COMMITTEE

(a) Laboratotries/Institutes Under the CSIR

1. National Chemical Laboratory, Poona
2. National Physical Laboratory, New Delhi
3. Central Fuel Research Institute, Jealgora
4. Central Glass & Ceramic Research Institute, Calcutta
5. Central Food Technological Research Institute, Mysore
6. National Metallurgical Laboratory, Jamshedpur
7. Central Drug Research Institute, Lucknow
8. Central Road Research Institute, New Delhi
9. Central Leather Research Institute, Madras
10. Central Building Research Institute, Roorkee
11. National Botanic Gardens, Lucknow
12. Central Mining Research Station, Dhanbad
13. Regional Research Laboratory, Hyderabad
14. Indian Instt. for Biochemistry & Exp. Medicine, Calcutta
15. Central Mechanical Engineering Research Instt., Durgapur
16. National Aeronautical Laboratory, Bangalore

(b) Co-operative Research Associations with Industry

1. Ahmedabad Textile Industry's Research Association, Ahmedabad
2. Bombay Textile Industry's Research Association, Bombay
3. Silk & Art Silk Mills Research Association, Bombay

(c) Other Establishments

1. Indian Institute of Science, Bangalore
2. Indian Statistical Institute, Calcutta
3. Indian Institute of Technology, New Delhi
4. Indian Institute of Management, Calcutta
5. Indian School of Mines & Applied Geology, Dhanbad
6. CIBA Research Centre, Bombay

7. Hindustan Lever Ltd., Bombay
8. Banaras Hindu University, Banaras
9. Delhi University, Delhi

LIST OF SCIENTISTS, INDUSTRIALISTS AND REPRESENTATIVES OF GOVERNMENT DEPARTMENTS WITH WHOM THE REVIEWING COMMITTEE HAD AN EXCHANGE OF VIEWS

(a) Scientists

1. Dr. D. Banerjee, President, Indian Rubber Manufacturers' Research Association, Calcutta.
2. Dr. U. P. Basu, Director, Bengal Immunity Research Instt., Calcutta.
3. Prof. S. N. Bose, National Professor, Deptt. of Physics, Calcutta University.
4. Dr. (Mrs.) Asima Chatterjee, Professor of Chemistry, Calcutta University.
5. Dr. D. B. Das, Hony. Secretary, Royal Institute of Chemistry, Eastern India Section, Calcutta.
6. Dr. B. B. Dixit, Director, All-India Institute of Medical Sciences, New Delhi.
7. Prof. T. R. Govindachari, Director, CIBA Research Centre, Bombay.
8. Dr. A. R. Kidwai, Head of the Department of Chemistry, Muslim University, Aligarh.
9. Dr. D. S. Kothari, Chairman, University Grants Commission, New Delhi.
10. Dr. R. C. Mehrotra, Dean, Faculty of Science, Rajasthan University, Jodhpur.
11. Prof. S. R. Palit, Professor of Physical Chemistry, Indian Association for the Cultivation of Science, Calcutta.
12. Dr. C. G. Pandit, Director, Indian Council of Medical Research, New Delhi.
13. Prof. B. D. Tilak, Professor of Dye-stuff Technology, University of Bombay, Bombay
14. Dr. Gurbaksh Singh, Head of the Chemistry Department, Banaras Hindu University.
15. Dr. A. R. Varma, Professor and Head of the Physics Department, Banaras Hindu University.
16. Prof. D. N. Wadia, F.R.S., Geological Adviser, Atomic Energy Department.

(b) Industrialists

1. Dr. K. F. Antia, Chief Executive, M. N. Dastur & Co., Consulting Engrs.

2. Shri G. L. Bansal, Secretary General, Federation of Chambers of Commerce & Industry, New Delhi.
3. Dr. B. P. Godrej, Bombay
4. Shri Kasturbhai Lalbhai, Ahmedabad
5. Shri P. A. Narielwala, Tata Industries, Bombay
6. Shri D. N. Sen, Industrialist & Chairman, Ex-Council, CG & CRI, Calcutta.
7. Shri Lakshmipat Singhania, Calcutta.
8. Dr. A. N. Puri. } All-India Manufacturers' Organisation re-
9. Dr. B. B. Bhutta. } presentatives.
10. Shri P. C. Chanda }
11. Shri Fazalbhoy } Indian Paint Research Association,
12. Dr. S. M. Das Gupta) } Calcutta
13. Representatives of Gujrat Millowers' Association.
14. Shri Y. A. Fazalbhoy, Bombay.

(c) Government Departments

1. Shri Nityanand Kanungo, Minister for Industry, Govt. of India, New Delhi.
2. Shri S. Ranganathan, Secretary, Ministry of Industry, New Delhi.
3. Shri S. S. Kumar, Director General, Directorate-General of Technical Development, New Delhi.
4. Dr. B. D. Kalelkar, Dy. Director General, Directorate-General of Technical Development, New Delhi.
5. Maj. Gen. B. D. Kapur, Chief Controller, Research & Development, Ministry of Defence, New Delhi.
6. Shri G. L. Mehta } Industrial Credit & Investment Corportion
7. Shri S. S. Mehta } of India, Bombay.
8. Shri A. R. Bhatt and Experts and Advisers } Indian Investment Centre, New Delhi.

ii) *Planning Commission*

1. Shri Asoka Mehta, Deputy Chairman
2. Shri T. N. Singh, Member (Industry)
3. Dr. V. K. R. V. Rao, Member (SL & T)
4. Shri Tarlok Singh, Member (A & T)
5. Dr. M. S. Randhawa, Adviser, Natural Resources

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(d) Directors of National Laboratories Separately Interviewed

1. Dr. K. Venkataraman, Director, National Chemical Laboratory, Poona.
2. Dr. K. S. G. Doss, Director, Central Electro-Chemical Research Institute, Karaikudi.
3. Dr. Amarjit Singh, Director, Central Electronics Engineering Research Institute, Pilani.
4. Dr. J. C. Ray, Director, Indian Instt. for Biochemistry & Experimental Medicine, Calcutta.

APPENDIX II

LIST OF NATIONAL LABORATORIES/INSTITUTES AND OTHER UNITS UNDER THE CSIR AS ON 31-12-1963

Sl. No.	Laboratory/Institute/Unit	Year of Establishment	Name of Director/ Principal Executive Officer
I.	**Research Laboratories/Institutes**		
1.	National Chemical Laboratory Poona	1950	Dr. K. Venkataraman
2.	National Physical Laboratory New Delhi	1950	Dr. P. K. Kichlu
3.	Central Fuel Research Institute Jealgora	1950	Dr. A. Lahiri
4.	Central Glass & Ceramic Research Institute, Calcutta	1950	Dr. Atma Ram
5.	Central Food Technological Research Institute, Mysore	1950	Dr. H. A. B. Parpia
6.	National Metallurgical Laboratory, Jamshedpur	1950	Dr. B. R. Nijhawan
7.	Central Drug Research Institute, Lucknow	1951	Dr. M. L. Dhar (Dy. Director-in-Charge)
8.	Central Road Research Institute, New Delhi	1952	Prof. S. R. Mehra
9.	Central Electro-Chemical Research Institute, Karaikudi	1953	Dr. K. S. G. Doss
10.	Central Leather Research Institute, Madras	1953	Dr. Y. Nayudamma
11.	Central Building Research Institute, Roorkee	1953	Shri Dinesh Mohan (Dy. Director-in-Charge)
12.	National Botanic Gardens, Lucknow	1953	Prof. K. N. Kaul
13.	Central Electronics Engineering Research Institute, Pilani	1953	Dr. Amarjit Singh

Sl. No.	Laboratory/Institute/Unit	Year of Establishment	Name of Director/ Principal Executive Officer
14.	Central Salt & Marine Chemicals Research Institute, Bhavnagar	1954	Dr. D. S. Datar (Dy. Director-in-Charge)
15.	Central Mining Research Station, Dhanbad	1955	Dr. K. N. Sinha (Officer-on-Spl. Duty)
16.	Regional Research Laboratory, Hyderabad	1956	Dr. G. S. Sidhu (Dy. Director-in-Charge)
17.	Indian Institute for Biochemistry and Experimental Medicine, Calcutta	1956	Dr. J. C. Ray
18.	Regional Research Laboratory, Jammu	1957	Dr. I. C. Chopra (Dy. Director-in-Charge)
19.	Central Mechanical Engineering Research Institute, Durgapur	1958	Shri G. S. Chowdhury (Dy. Director-in-Charge)
20.	Central Indian Medicinal Plants Organisation, Lucknow	1959	Dr. B. N. Mitra
21.	Central Public Health Engineering Research Institute, Kanpur	1959	Shri R. S. Mehta
22.	Central Scientific Instruments Organisation, Chandigarh	1959	Dr. P. S. Gill
23.	National Aeronautical Laboratory, Bangalore	1960	Dr. P. Nilakantan (died on 18-4-1964)
24.	Indian Institute of Petroleum, Dehra Dun	1960	Dr. M. G. Krishna (Dy. Director-in-Charge)
25.	National Geophysical Research Institute, Hyderabad	1961	Dr. S. Balakrishna (Asstt. Director-in-Charge)
26.	Regional Research Laboratory, Jorhat	1961	Shri E. Ehsanullah (Asstt. Director-in-Charge)
27.	Indian Ocean Expedition, New Delhi	1962	Dr. N. K. Panikkar
II.	**Industrial & Technological Museums**		
28.	Birla Industrial & Technological Museum, Calcutta	1959	Shri S. K. Bagchi (Curator-in-Charge)

Sl. No.	Laboratory/Institute/Unit	Year of Establishment	Name of Director/ Principal Executive Officer
29.	Visvesvaraya Industrial & Technological Museum, Bangalore	1962	Shri A. Bose (Officer-in-Charge)
III.	**Scientific & Technical Services Organisations & Units**		
30.	Patents Unit	1942	Shri R. B. Pai (Patents Officer)
31.	National Register for Scientific and Technical Personnel	1948	Shri K. Ray (Deputy Director)
32.	Information & Publications Directorate	1951	Shri A. Rahman (Chief Editor)
33.	Indian National Scientific Documentation Centre	1951	Shri B. S. Kesavan (Director)
34.	Defence Coordination Unit	1962	Shri A. K. Bose (Defence Coordination Officer)
35.	Research Coordination, Industrial Liaison & Extension Services Unit	1963	Shri Baldev Singh, (Research Coordination, Industrial Liaison & Extension Officer)
36.	Central Design & Engineering Unit	1963	Dr. K. S. Chari (Deputy Director)
37.	Survey & Planning of Scientific Research Unit	1963	Shri A. Rahman (Officer-on-Spl. Duty)

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STATEMENT ON COOPERATIVE RESEARCH ASSOCIATIONS

Sl. No.	Cooperative Research Association	Year of Establishment	Industry served	Chief Executive Officer	CSIR Financial Support		
					1961-62	1962-63	1963-64
						(Rs. in millions)	
1.	Ahmedabad Textile Industry's Research Asson., Ahmedabad	1947	Cotton Textile Industry	Dr. T. S. Subramaniam	0.6740	0.5217	0.6340
2.	South India Textile Research Association, Coimbatore	1956	Cotton Textile Industry	Shri K. Srinivasan	0.2480	0.5140	0.2675
3.	Silk & Art Silk Mills Research Association, Bombay	1957	Art Silk Industry	Shri J. G. Parikh	0.2196	0.2178	0.2400
4.	Indian Rubber Manufacturers' Research Asson., Calcutta.	1959	Rubber Industry	Dr. D. Banerjee	0.0032	0.0120	0.0071
5.	Bombay Textile Research Association, Bombay	1960	Cotton Textile Industry	Dr. C. Nanjundayya	0.4176	0.4440	0.4208
6.	Indian Plywood Industries Research Association, Bangalore	1960	Plywood Industry	Dr. D. Narayanamurthi	...	0.0200	0.1530
7.	Indian Paint Research Asson., Calcutta	1962	Paint Industry	Shri P. C. Chanda	...	...	...
8.	Tea Research Institute, Toklai (Assam)	1963	Tea Industry	Shri N. G. Gokhale	...	...	0.2000
				TOTAL	1.5624	1.7295	1.9224

APPENDIX IV

TABLE SHOWING GROWTH OF ACTIVITIES OF THE CSIR
1954-1963

Year	Research Institutes	Museums	Scientific & Tech. Organisation	Budget (million) Rs.	Staff strength	
					Scientists & Technologists	Total employees*
1954-55	14	—	4	21.6757	550	2993
1955-56	15	—	4	27.4868	570	3038
1956-57	17	—	4	30.9060	702	4680
1957-58	18	—	4	36.5836	846	5475
1958-59	19	—	4	47.2507	1080	6422
1959-60	22	1	4	59.1780	1354	7309
1960-61	24	1	4	68.7759	1557	8305
1961-62	26	1	4	81.2830	1793	9478
1962-63	27	2	5	95.8725	2134	10865
1963-64	27	2	8	117.5000	2435	11319

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*Includes scientific, auxiliary, technical, administrative and class IV employees.

GROWTH OF ACTIVITIES OF CSIR

Year	Research Fellowships			Research Schemes		Scientists' Pool	
	Senior	Junior	Total	Number	Expenditure (million Rs.)	Number	Expenditure (million Rs.)
1955-56	—	—	—	139	0.384698		
1956-57	—	—	—	228	1.302449		
1957-58	—	2	2	380	1.543601		
1958-59	19	43	62	332	2.109396		
1959-60	46	132	178	383	2.868230	197	
1960-61	84	209	393	419	3.173011	360	0.0192
1961-62	114	376	490	398	2.688732	887	0.2724
1962-63	101	364	465	460	2.546138	1280	0.9648
1963-64	353	1212	1565	518	2.570771	2119	1.7960
1964-65	368	1087	1455	562	4.780230	2795	2.7647
	(upto 24-7-64)					(as on 1-8-1964)	

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